VEGA USER'S MANUAL

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VEGA
User's Manual

Approved and issued by **ARIANESPACE**

Edouard PEREZ

Senior Vice President Engineering

Siège social / Headquarters
Boulevard de l'Europe
B.P. 177
91006 Evry-Courcouronnes cedex
France

Tel : +33 1 60 87 60 00
Fax : +33 1 60 87 62 47

S.A. au capital de 2 087 910 000 F
RCS Evry B 318 516 457

Washington, D.C.,U.S.A.
Tel : +1 202 628-3936
Fax : +1 202 628-3949

Singapore
Tel : +65 223 6426
Fax : +65 223 4268

Tokyo
Tel : +81 3 3592-2766
Fax : +81 3 3592-2768

Kourou
Tel : +594 33 67 07
Fax : +594 33 62 66

www.arianespace.com

VEGA
User's Manual

Preface

This document contains the technical information which is necessary :

a/ to assess compatibility of a spacecraft with the VEGA launches,
b/ to prepare all the technical and operational documentation related to a launch of any spacecraft on VEGA.

This document written in collaboration with ELV S.p.A. will be revised periodically, comments and suggestions on all aspects of this manual will be encouraged and appreciated.

Inquiries concerning clarification or interpretation of this manual should be directed to:

ARIANESPACE
Programmes Division
Technical Service

B.P. 177
91006 EVRY Courcouronnes Cedex
France

Telephone: +33 160 87 60 00
Telefax : +33 160 87 62 17

FOREWORD

The VEGA development program is carried out under the aegis of the European Space Agency (ESA) and under the management of the Italian ELV S.p.A Company.

It is financed by the following participating European states: Belgium, Italy, the Netherlands, Spain, Sweden, Switzerland and France.

Following a decision by the participating States the responsibility for the marketing and launching of operational VEGA vehicle and its updated versions will be entrusted to ARIANESPACE.

VEGA Production and launch capability are sized such as to enable at least four launches per year on average during at least ten years of operations.

VEGA Production benefits from reuse of already developed, under development equipment, including subsystem, materials and all Ariane units.

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I – ARIANESPACE: A PRIVATE COMPANY

ARIANESPACE is a French **Joint Stock Company** ("Société Anonyme") which was incorporated on March 26th 1980. Its authorized capital amounts to 317 millions Euros

The 52 shareholders partners in ARIANESPACE represent the scientific, technical, financial and political capabilities of **11 European countries** (Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland and United Kingdom).

In order to meet the market needs, ARIANESPACE has established a worldwide presence: in Europe, with it head office located at Evry near Paris, France, in North America with Arianespace Inc., its subsidiary in Washington D.C., and in the Pacific Region, with its representative offices in Tokyo (Japan) and Singapore.

II – A RESPONSIBLE COMPANY

ARIANESPACE has adopted the structure of a commercial and engineering company fully responsible for financial results, in order to provide three main functions:

1. **MARKETING AND SALES OF SATELLITE LAUNCH SERVICES** to all customers throughout the world,

2. **PRIME CONTRACTOR RESPONSIBILITIES FOR PRODUCTION AND FINANCING** on operational european launch vehicles;

3. **OPERATIONS DIRECTORATE** using the launchers launch sites at the Guiana Space Center in Kourou.

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III – A SERVICE COMPANY

Arianespace's objective is to provide a complete, personalized service, covering the entire period from initiate formulation of the project with the Customer and its satellite manufacturer, up to the launch.

This objective is achieved by the combination of a product such as the Ariane and VEGA Launchers, fully automatic and optimized for this type of mission, and a modern launch complex equipped with all the facilities required for the preparation and testing of the latest generation of satellites, and manned by skilled technicians and engineers used to working with the latest state of the art technology.

In the area of insurance, ARIANESPACE created the subsidiary S.3.R. which provide additional insurance capacity to aid its clients with coverage during the launch phase.

I – ELV S.p.A.: A PRIVATE COMPANY

First European Industrial Company in charged as Prime Contractor and Industrial Architect towards VEGA launcher development.

Established on December 22, 2000 under the name of ELV S.p.A.
Registered on January 23, 2001.

Headquarters are located in Roma.
Operating Base in Colleferro.
Office in ASI site in Roma.

II – A RESPONSIBLE COMPANY

The Objectives assigned to the Company concern the field of small launcher systems with particular reference to:

1. **PROGRAMME MANAGEMENT** and System activities dedicated to design and development of VEGA Launch Vehicle.

2. **COORDINATION and MONITORING** of the manufacturing of the VEGA Launch Vehicle,

3. **MANAGEMENT** of research and development programs in the field of small launch vehicles.

III – A SERVICE COMPANY

ELV S.p.A's objective of the VEGA Small Launcher development is to provide Europe with a cost effective launch capability supplementary to the well proven Ariane launcher family.

User’s Manual Configuration Control Sheet

Issue / Revision	Date	New sheets	Approval
0 / 0	**March 2002**	All	C. Berna

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Acronyms & Abbreviations

Note : In this part are listed the acronyms of terms more used on the VEGA Launch Vehicle. Many of them, being relevant to common equipment, documents or Techniques already used and qualified on ARIANE 5, but adopted on the VEGA Program, are herein listed in their original French Language in *Italics.*

AAC	Aft Access Closure	
AAM	AVUM Avionic Module	
AAS	AVUM Avionic Section	
ABCL	As Built Configuration List	
ABM	Apogee Boost Motor	
ACP	Acoustic Protection	
ACS	Attitude Control System	
ACT	Attitude Control Thruster	
ACU	*Adaptateur Charge Utile*	Payload Adapter
ACU	*Adjoint Charge Utile* Payload/Launcher Interface Manager	
AD	Applicable Document or Application Directive	
A/D	Analog to Digital	
AE	Arianespace	
AE	Approach Ellipsoid	
AGC	Automatic Gain Control	
AIS	Avionic Interface Software	
AIT	Assembly, Integration and Test	
AIV	Assembly Integration and Verification	
AKM	Apogee Kick Motor	
ALU	Arithmetic Logic Unit	
AM	Avionic Module	

AME	AVUM Main Engine
AOA	Angle Of Attack
AOCS	Attitude and Orbit Control System
AOS	Acquisition of Signal
AP	Application Plan
APM	AVUM Propulsion Module
APS	AVUM Propulsion Section
AR	Acceptance Review
AS	Auxiliary Supply
ASAP	Ariane Structure for Auxiliary Payload
ASIC	Application Specific Integrated Circuit
ASE	*Agence Spatiale Européenne* European Space Agency
ATD	*Antenne de TeleDestruction* Command Antenna
ATJ	*Antenne de Trajectographie* Trajectory Antenna
ATM	*Antenne de Télémesure* Telemetry Antenna
ATP	Acceptance Test Procedure
AVUM	Attitude and Vernier Upper Module
AZ	Azimuth
BB	Bus Bar
BC	Bus Controller
BCS	*Boîtier de Commande Sauvegarde* Safety Command Box
BD	Burst Disk
BDP	*Boîtier de Distribution de Puissance* Power Distributive Box
BDR	Battery Discharge Regulator
BEAP	*Banc d'Essais des propulseurs d'Appoint à Poudre*
BER	Bit Error Rate
BET	Best Estimate of Trajectory

BIP	*Bâtiment d'Integration Propulseur*	
BIT	Built In Test	
BITE	Built-In Test Equipment	
BIU	Bus Interface Unit	
BIV	*Bâtiment d'Integration VEGA*	
BLA	*Base de Lancement Ariane*	
BMU	*Boîtier Multivie Unidirectionel*	
BOL	Beginning Of Life	
BPS	Bit Per Second	
BSA	*Barriére de Sécurité et d'Armement*	
BV	*Bouchon de Vol*	Flight Plug
CA	Criticality Analysis	
CAD	Computer Aided Design	
CAD	Cartridge Actuated Device	
CADM	Configuration And Data Management	
CAM	Collision Avoidance Manoeuvre	
CAM	Computer Aided Manufacturing	
CAP	Contractual Authorization to Proceed	
CA5	*Coupleur ARIANE 5*	
CCB	Configuration Control Board	
CCU	*Conteneur Charge Utile*	Payload Container
CDC	Confined Detonating Cord	
CDF	*Cahier des Charges Fonctionnelles*	
CDF	Cumulative Density Function	
CDL	*Centre de Lancement*	Launch Centre
CDR	Critical Design Review	
CEC	Current Economic Conditions	

CEP	Circle of Equal Probability	
CF	*Cahier Fonctionnel*	
CI	Configuration Item	
CI	Critical Item	
CLA	Coupled Load Analysis	
CLA	Center Line Average	
CM	Configuration Management	
CM	*Chef de Mission*	Mission Director
CM	Corrective Maintenance	
COEL	*Chef des Opérations Ensemble de Lancement* Launch Site Operations Manager	
COG	Center of Gravity	
COTE	Check-Out Terminal Equipment	
COTS	Component On The Shelves	
COV	Cut Off Valve	
CP	*Chef de Projet*	*Project Director*
CP	Change Proposal	
CPVP	*Chef de Projet Vega Production*	
CPO	Circular Polar Orbit	
CPS	*Chef de Projet Satellite*	Satellite Project Manager
CQ	*Certificat de Qualification*	
CR	*Concept Review*	
CR	*Compte-Rendu*	
CRSS	Clamp Ring Separation System	
CSG	*Centre Spatial Guyanais*	
CU	Conditioning Unit	
CU	*Charge Utile*	Payload
D/A	Digital to Analog	

DAM	*Dossier d'Analyse de Mission* Mission Analysis Document
DAMF	*Dossier d'Analyse de Mission Finale* Final Mission Analysis Document
DAMP	*Dossier d'Analyse de Mission Préliminaire* Preliminary Mission Analysis Document
dB	DeciBel
DB	Data Base
DBL	Development Base Line
dc	direct current
DC	*Dossier de Coûts*
DC	Duty Cycle
DCI	*Dossier de Contrôle des Interfaces* Interface control File
DCS	Dynamic Control Software
DDO	*Directeur d'Opérations* Range Operations Manager
DDT	Deflagration to Detonation Transition
DF	*Dossier Fonctionnel*
DI	*Dossier Industriel*
DIC	*Dossier Industriel de Contrôle*
DID	*Dossier Industriel de Définition*
DIF	*Dossier Industriel de Fabrication*
DJ	*Dossier Justificatif*
DJI	*Dossier Justificatif des Interfaces*
DL	*Demande de lancement* Launch Requirements Document
DM	Development Model
DMS	*Directeur de la Mission Satellite* Satellite Mission Director
DOE	Design Of Experiments
DOF	Degree Of Freedom

DOP	Duct Over Pressure	
DR	Design Review	
DRB	Delivery Review Board	
DRD	Document Requirement Description	
DTC	Design To Cost	
DUV	*Demande d'Utilisation Vega*	Application to use Vega
DV	*Directeur de Vol*	Flight Director
EBW	Exploding Bridge Wire	
ECEF	Earth Centered Earth Fixed	
ECOS	ESA Costing Software	
ECP	Engineering Change Proposal	
ECN	Engineering Change Notice	
ECSS	European Cooperation for Space Standardisation	
EEE	Electric, Electronic, Electromechanical	
EED	Electro-Explosive Device	
EFI	Exploding Foil Initiator	
EIDP	End Item Data Package	
EGSE	Electrical Ground Support Equipment	
ELA	*Ensemble de Lancement Ariane*	
ELA 3	*Ensemble de Lancement Ariane 5*	
EM	Engineering Model	
EMA	Electro Mechanical Actuator	
EMC	Empty Motor Case	
EMC	Electro Magnetic Compatibility	
EMI	Electro-Magnetic Interference	
EMP	Electro-Magnetic Pulse	
EOL	End Of Life	
EPCU	*Ensemble de Preparation des Charges Utiles*	

EPDS	Electrical Power and Distribution System
EPE	*Electronique de Pilotage Electrique*
EPEV	Electro-actuators Piloting Equipment Vega
EPDM	Ethylene Propylene Diene Monomer
EPDS	Electrical and Power Distribution Sub-system
EPH	*Electronique Pilotage Hydraulique*
EPHV	*Electronique Pilotage Hydraulique VEGA*
EPSS	Electrical Power Supply Sub System
EQM	Engineering Qualification Model
ES	*Electronique Sequentielle*
ESA	European Space Agency
ESD	Electro-Static Discharge
ESE	Earth Sensor Electronics
ESI	European Standard Initiator
ET	Explosive Train
ETA	Explosive Transfer Assembly
ETSS	Expanding Tube Separation System
EXP	Exponent
FA	*Fiche d'Anomalie*
FBAT	Functional Battery
FB	Functional Baseline
FCDC	Flexible Confined Detonating Cord
FCI	Fracture Critical Item
FCR	Flight Control Reference
FCS	Flight Control System
FCV	Flow Control Valve
F/DV	Fill & Drain Valve
FEM	Finite Element Model

FFF	Form Fit Function
FFT	Fast Fourier Transform
FGSE	Fluid Ground Support Equipment
FIR	Fairing Interface Ring
FLSC	Flexible Linear Shaped Charge
FM	Flight Model
FM	Flight Modulation
FMEA	Failure Mode and Effect Analysis
FMECA	Failure Mode, Effects and Criticality Analysis
FO	Fail Operational
FPS	Flight Program Software
FR	Failure Rate
FRB	Failure Review Board
FRR	Flight Readiness review
FQR	Flight Qualification Review
FS	Fail Safe
FS	Flight Spare
FSS	Fairing Separation System
FT	Fuel Tank
FTA	Fault Tree Analysis
FTC	Fault Tolerant Computer
FTP	Fault Tolerant Processor
FTS	Flight Termination System
F/V	Fill and Vent
FW	Filament Winding
F/W	Firm/Ware
GEO	Geostationary Orbit
GFIL	Gas Filter

GMB	Gimba
GMT	Greenwich Mean Time
GNC	Guidance Navigation Control
GOR	Ground On-board Relay
GNC	Guidance, Navigation and Control
GPR	Gas Pressure Regulator
GPS	Global Positioning System
GQR	Ground Qualification Review
GRP	Ground Reference Point
GSE	Ground Support Equipment
GT	Gas Tank
GTE	Ground Test Equipment
GTO	Geostationnary Transfer Orbit

HBW	Hot Bridge Wire
HEO	Highly Elliptical Orbit
HFE	Human Factors Engineering
HL	High Level
HM	Hardware Matrix
HP	High Pressure
HPPY	High Pressure PyroValve
HPT	High Pressure Transducer
HRN	Harness
HSS	Horizontal Separation System (Fairing)
HTPB	Hydroxyl Terminated Poly Butadiene
HV	High Voltage
H/W	HardWare
HWIL	Hardware In the Loop

iaw	In accordance with
IAN	Instantaneous Automatic Neutralisation
ICD	Interface Control Document
i.d.	Inside Diameter
ID	Inadvertent Destruction
I/F	InterFace
IFOC	*Initiateur Fonctionnant par Onde de Choc*
IFFT	Inverse Fast Fourier Transform
IGN	Igniter
IIP	Instantaneous Impact Point
ILS	Integrated Logistic Support
IM	Integration Model
IMC	Insulated Motor Case
IMU	Inertial Measurement Unit
IMV	Inter Module Venting
INS	Inertial Navigation System
I/O	Input/Output
IOCL	Input Output Communication Logic
IOP	Ignition Over Pressure
IPT	Integrated Project Team
IRB	Internal Review Board
I/S	Inter Stage
ISCU	*Ingénieur Sauvegarde Charge Utile* Payload safety Officer
ISLA	*Ingénieur Sauvegarde Ensemble de lancement* Launch Area Safety Officer
ISO	International Standards Organization
ISV	Inert Static Vehicle
ITF	Integration and Test Facility

KIP	Key Inspection Point
KM	Kick Motor
KRU	Kourou
KW	Kilo Watt
LAM	*Laboratoire d'Appareils de Mesure* Measuring instrument Laboratory
LAN	Local Area Network
LB	Launch Base
LBB	Leak Before Burst
LBC	*Local Banc de Contrôle* Check-Out Equiment Room
LC	Load Cell
LCC	Life Cycle Cost
LCCD	Linear Charge Cord Device
LCM	Loaded Case Motor
LCP	Left Circular Polarisation
LEO	Low Earth Orbit
LETO	Low Earth Transfer Orbit
LL	Low Level
LMC	Loaded Motor Case
LN	Liner
LNA	Low Noise Amplifier
LN1,2,3	*Logiciel de Niveau 1,2,3*
LOS	Loss Of Signal
LP	Low Pressure
L/P	Launch Pad (launch site)
LPS	Liquid Propulsion System
LPT	Low Pressure Transducer
LRR	Launch Readiness Review

LST	Local Sideral Time
LTD	*Liaisons Transmission de Données* Data transmission links
LV	Launch Vehicle
LVDT	Linear Variable Differential Transformer
LVLH	Local Vertical Local Horizontal
LW	Launch Window
MAIT	Manufacturing Assembling Integration Testing
MAR	Mission Analysis Review
MB	Mega Byte
MBPS	Mega Byte Per Second
MC	Motor Case
MCC	Mission Control Center
MCC	Motor Case Cutter
MCI	Mass, Center of gravity, Moment of Inertia
MDF	Mild Detonating Fuze
ME	Main Engine
MECO	Main Engine Cut Off
MEO	Medium Earth Orbit
MEOP	Maximum Expected Operating Pressure
MF	Main Function
MFU	Multi-Functional Unit
MGSE	Mechanical Ground Support Equipment
MIB	Minimum Impulse Bit
MIP	Mandatory Inspection Point
MLD	Mean Logistic Delay
Mo	Mean Anomaly
MOI	Moment Of Inertia

MPS	Moteur a Propergol Solide
MR	Management Rule
MRB	Material Review Board
MRT	Mean Repair Time
MS	Margin of Safety
MTBF	Mean Time Between Failure
MTC	Market Cost Target
MTTF	Mean Time To Failure
MTTFF	Mean Time To First Failure
MTTR	Mean Time To Restoration (Repair)
MU	Mock Up
MUV	*Manuel Utilisateur VEGA*
MUX	Multiplexer
NA	Not Applicable
NASA	National Aeronautics and Space Administration
NBC	Nozzle Base Cover
NCR	Non Conformance Report
NDT	Non Destructive Test
NR	Noise Reduction
NRV	Non Return Valve
NSI	NASA Standard Initiator
NT	*Note Technique*
NTC	Negotiated Cost Target
NTO	Nitrogen TetrOxyde
N^2O^4	Nitrogen Tetroxyde
NZL	Nozzle
OBC	On Board Computer

OBD	On Board Database	
OBDH	On Board Data Handling	
OBSW	On Board SoftWare	
OCOE	Overal Check-Out Equipment	
OD	Outside Diameter	
OFT	Orbital Flight Test	
OLG	Open Loop Gain	
OLR	Out-going Long-wave Radiation	
OR	Oil Reservoir	
ORU	Orbit Replaceable Unit	
OT	Oxidizer Tank	
OTS	Off The Shelf	
OXR	Oxidizer	
PA	Product Assurance	
PA	*Protection Acoustique*	Acoustic Blanket
PAM	Pulse Amplitude Modulation	
PAP	*Propulseur d'Appoint à Poudre* Solid propellant strap-on booster	
PBL	Product Base Line	
PC	Project Control	
PCA	Physical Configuration Audit	
PCD	Product Configuration Documentation	
PCM	Pulse Code Modulation	
PDB	Power Distribution Box	
PDR	Preliminary Design Review	
PDU	Power Distribution Unit	
PE	*Plan d'Essai*	
PEQ	*Plan d'Essais de Qualification*	

PETN	Penta Erythrol Tetra Nitrate	
PFC	Pyrotechnic Firing Circuit	
PFCU	*Plate Forme Charge Utile*	Payload platform
PFIL	Propellant Filter	
PFR	Post Flight Review	
PFQR	Post Flight Qualification Review	
PG	Propellant Grain	
PIP	*Prise d'Interception Pyrotechnique* Pyro Interception Plug	
P/L	Payload (Satellite, Spacecraft)	
PM	Preventive Maintenance	
PM	Program Manager	
PM	*Proposition de Modification*	
PMBT	Propellant Mean Bulk Temperature	
PMD	Propellant Management Device	
PMP	Parts, Materials and Processes	
PMPL	Parts, Materials and Processes List	
POC	Combined Operation Phase	
POE	*Prise Ombilicale Electrique*	Electrical Umbilical Plug
POI	*Plan des Opérations satellite Imbriquées* Interleaved spacecraft Operations Plan	
POP	*Prise Ombilicale Pneumautique* Pneumatic Umbilical Plug	
POS	Plan d'Opérations Saytellite	
PPL	Preferred Part List	
PPLS	Propellant and Pressurant Loading Systems	
PRA	Process Risk Analysis	
PRR	Production Readiness Review	
PS	Proximity Sensor	
PSD	Power Spectral Density	

PSU	Power Supply Unit
PT	Pressure Transducer
PT	Product Tree
PW	Pulse Width
P/Y	Pitch and Yaw
PYB	Pyro Battery
PYCB	Pyro Control Box
QA	Quality Assurance
QC	Quality Control
QDR	Quick Disconnect Return
QDS	Quick Disconnect Supply
QML	Qualified Manufacturers List
QPL	Qualified Parts List
QR	Qualification Review
QSL	Quasi Static Loads
RAAN	Right Ascension of Ascending Node
RAL	*Revue Avant Lancement* Launch Readiness Review
RAM	*Revue d'Analyse de Misssion* Mission Analysis review
RAMF	*Revue d'Analyse de Misssion Finale* Final Mission Analysis review
RAMP	*Revue d'Analyse de Misssion Préliminaire* Preliminary Mission Analysis review
RAV	*Revue d'Aptitude au Vol* Flight Readiness Revew
RAVL	*Revue d'Aptitude au Vol du Lanceur* Launch Vehicle Flight Readiness Review
RAVS	*Revue d'Aptitude au Vol du Satellite* Satellite Flight Readiness Review
RAMS	Reliability, Availability, Maintainability, Safety
RC	*Registre de Configuration.*

RC	Re-transmitted Command
RC	Remote Control
RCI	*Registre de Controle Individuel*
RCP	Right Circular Polarisation
RCS	Reaction Control System
RCT	Reaction Control Thruster
RCW	Raceways
R.D.	Reference Document
REC	Reference Economic Conditions
RETA	Rigid Explosive Transfer Assembly
RF	Radio Frequency
RFD	Request For Deviation
RFQ	Request For Quotation
RFW	Request For Waiver
RH	Relative Humidity
RID	Review Item Discrepancy
RMS	Root Mean Square
RMS	Root Mean Square.
ROM	Rough Order of Magnitude
RPM	Rotation Per Minute
RPS	*Responsable Preparation Satellite* Spacecraft Preparation Manager
RR	*Répondeur Radar*
RRD	Reference Rod
RT	Radar Transponder
RTC	*Récepteur TéléCommande*
RTW	Radio Transparent Window
RTX	Radio Destruction Receiver
RS	*Responsable Sauvegarde* Safety Manager

RS	*Règlement Sauvegarde*	Safety Regulation Rules
RV	Relief Valve	
S1	Buildings S1 Spacecraft preparation	
S2	Building S2 SPM preparation	
S3	Buildings S3 Spacecraft filling & Assembly	
S4	Building S4 SPM X-Ray	
S5	Buildings S5 New EPCU complex buildings	
SAA	Servo Actuator Assy	
SAD	Safe/Arm Device	
SAD I	Safe and Arm Device for the ignition system	
SAD FS	Safe and Arm Device for the fairing separation system	
SAD SN	Safe and Arm Device for the stages neutralisation	
SAD SS	Safe and Arm Device for the Stages Separation	
SAS	Safety Sub System	
SB	Safety Battery	
S-BT	S-Band Transmitter	
SC	Stress Corrosion	
SCA	*Système de Contrôle d'Attitude* Attitude Control system	
SCOE	Satellite Check-Out Equipment	
SCR	Safety Control Relay	
SCS	Synthesis Control Software	
S/C	Space/Craft	
SDE	Software Development Environment	
SDR	System Design Review	
SEA	Statistic Energy Analysis	
SET	Significant Effects Threshold	
SES	Separation System	

SFP	Single Failure Point	
SM	Structural Model	
SMDC	Shielded Mild Detonating Cord	
SMU	Safety Master Unit	
SG	*Spécification Générale*	
SI	*Spécification d'Interface*	
SIW	Satellite Injection Window	
SL	Sea Level	
SLV	*Site de Lancement VEGA*	VEGA Launch Site
SMDC	Shielded Mild Detonating Cord	
SMO	*Spécification de Mise en Oeuvre*	
SMU	Safety Master Unit	
S/N	Serial Number	
S/N	Signal to Noise ratio	
SOV	Solenoid Valve	
SOW	Statement Of Work	
SPL	Sound Pressure Level	
SPM	Solid Propellant Motor	
SR	Slew Rate	
SRM	Solid Rocket Motor	
SRU	Safety Remote Unit	
SRS	Shock Response Spectrum	
STE	Satellite Test Equipment	
STM	Structural Thermal Model	
STR	Structure	
S/S	Subsystem	
SSA	S-Band Single Access	
SSB	Single Side Band	
SSE	Sun Sensor Electronics	

SSO	Sun Synchronous Orbit
SSOH	Sun Sensor Optical Head
SSR	System Requirement Review
SSS	Separation Sensing Strap
SSU	Sun Sensor Unit
ST	*Spécification Technique*
SVF	Software Validation Facility
SV	Solenoid Valve
SVS	Sign Verification Software
SW	SoftWare
TB	Thermal Battery
TBC	To Be Confirmed
TBD	To Be Done or To Be Defined
TBI	Through Bulkhead Initiator
TC	TeleCommand
TF	Transfer Function
T/L	Transporter/Launcher
TM	TeleMetry
TMSS	TeleMetry Sub System
TND	Transducer
TNO	Tetra Oxide of Nitrogen
TO	Transfer Orbit
TP	Thermal Protection
TPD	Thermal Packaging & Depressurization
TT&C	Telemetry Tracking & Command
TTF	Target Test Facilities
TR	Telecommand Receiver
TRB	Test Readiness Board

TRR	Test Readiness Review	
TVC	Thrust Vector Control	
UA	*Unité d'Acquisition*	Acquisition Unit
UCTM	Unité Centrale de Télémesure	
UDMH	Unsymmetrical DiMethyl Hydrazine	
UDTM	*Unité Deportée de Télémesure*	
UHF	Ultra High Frequency	
UIA	UHF Interface Adapter	
UMMH	Unsymmetrical Mono Methyl Hydrazine.	
UPG	*Usine de Propergol Guyane*	
UT	Universal Time	
UTC	Universal Time Code	
UTS	Ultimate Tensile Strength	
VCD	Verification Control Document	
VEB	Vehicle Equipment Bay	
VHF	Very High Frequency	
VR	Relative Velocity	
VSS	Vertical Separation System (P/L Fairing)	
WBS	Work Breakdown Structure	
WCA	Worst Case Analysis	
WGS	World Geodetic System	
WP	Work Package	
WPD	Work Package Description	
ZL	*Zone de Lancement*	Launch area
ZP	*Zone Protégée*	Safe area

ZP	*Zone de préparation*	Preparation zone
ZSP	*Zone de Stockage des Propulseurs* Solid Propellant storage area	
a	Semi-major axis	
e	Eccentricity	
i	Inclination	
ω	Argument of perigee	
Ω	Ascending node	
ΩD	Descending node	
Za	Apogee altitude	
Zp	Perigee altitude	

Chapter 1
Introduction

Introduction Chapter 1

1.1. Purpose of the User's manual

This manual is intended to provide Users with information of the VEGA launch vehicle.

The following three documents:

- The VEGA User's Manual,
- The C.S.G. Safety Regulations applicable for spacecraft design and operations
- The Payload Preparation Complex (E.P.C.U.) Manual (CD-ROM).

constitute the VEGA technical reference documentation used for the VEGA / Spacecraft feasibility analysis phase studies.

On completion of the feasibility phase, formal documentation will be established in accordance with the procedures outlined in Chapter 6 of this manual.

1.2. The VEGA launch system

Arianespace offers a complete launch system including the vehicle, the launch facilities and the associated services.

The launch vehicle is basically the VEGA four-stage-vehicle.

The VEGA Launch System is composed of:

- The VEGA Launch Vehicle,
- The VEGA Launch Complex,
- The VEGA Ground Support Equipment.

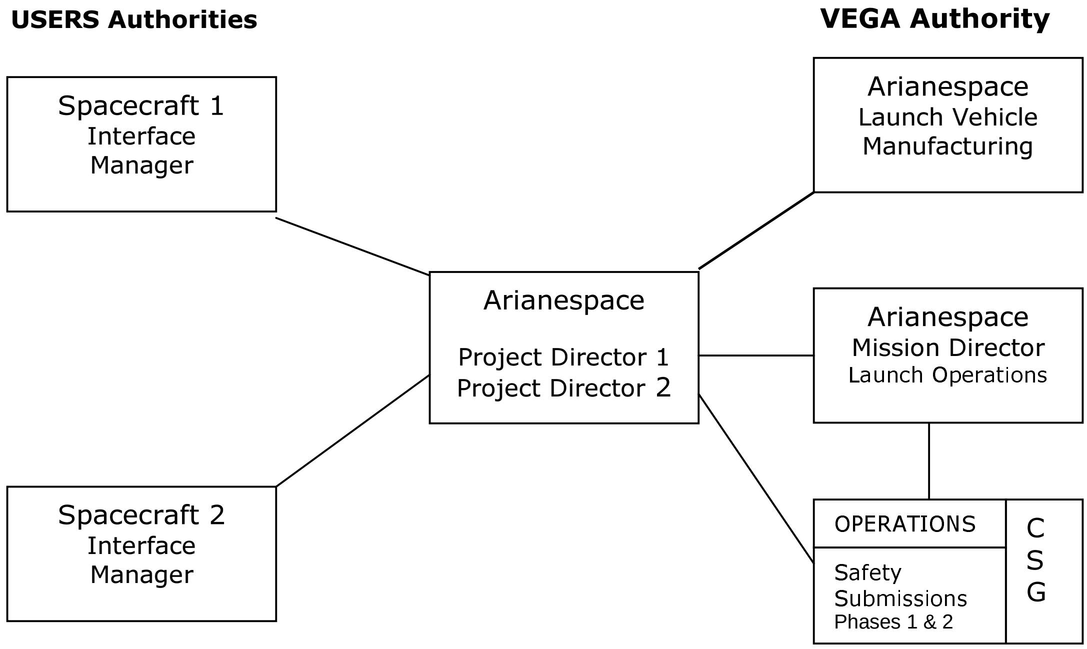
The launch facilities located in French Guiana comprise the Payload Preparation Complex EPCU and the VEGA Launch Complex – **S**ite de **L**ancement **V**EGA - **SLV**.

Arianespace is organized to offer a Launch Service based on a continuous interchange of information between a Spacecraft Interface Manager (User), and the VEGA Project Director (Arianespace) who are appointed at the time of the launch contract signature.

As from that date, the VEGA Project Director is responsible for the execution of the Launch Service Contract.

For a given launch, therefore, there are per satellite one Spacecraft Interface Manager and one VEGA Project Director.

For the preparation and execution of the French Guiana operations, the VEGA launch team is managed by a specially assigned Mission Director who will work directly with the User's operational team.



Principle of Users/Arianespace Relationship

VEGA Lift-Off – Artist view

1.3. The VEGA Launch Vehicle

1.3.1 VEGA Launch Vehicle architecture

The VEGA launch vehicle is basically composed of the 1st, 2nd and 3rd solid fuelled stages, and a bipropellant (UDMH/NTO) upper (4th) stage. The AVUM is made in two parts, the APM with the propulsion elements and the AAM with the electronic components. The Fairing comprises the satellite(s) with their adaptors.

See Figure 1.1 showing the expanded view of VEGA Launch Vehicle.

1.3.1.1 The First STAGE.

The first stage in ground configuration has an overall length (including nozzle protrusion) of 11.8 meters, with a diameter of 3 meters.

The first stage propulsion is a based on a new high performance European **S**olid **R**ocket **M**otor (**SRM**), named P80 FW, to be developed by Fiat Avio as Prime Contractor with the support of Europropulsion (for the motor system and for Assembly, Integration and Testing), of SNECMA (for the nozzle development) and of TNO-Stork (for Igniter development).

This new SRM will also allow the development of the newest technologies relevant to solid propulsion, to be applied to the next generation of European SRM's and for improved versions of existing ones (Ariane MPS 2010 e.g.).

The propellant grain shape is finocyl type, with the star section positioned in the aft zone of the motor (nozzle side) and a weight of 84 tons.

The P80 FW SRM employs a carbon-epoxy filament wound monolithic motor case, protected by a low density EPDM based thermal insulation, charged with glass microspheres.

The nozzle is composed of :

- A 3-D Carbon/Carbon throat,
- A self protected flexible joint,
- A carbon phenolic exit cone, providing insulation and mechanical strength
- An actuator attachment ring, joined to the exit cone by means of overlapped structures.

The flexible joint allows a maximum nozzle geometric deflection of 8 degrees in every directions, that is consistent with the nozzle deflection required for LV controllability. The nozzle throat diameter is 468 mm, while the expansion ratio is 16.

P80 FW maximum (on the nominal curve) of vacuum thrust and pressure are 2974 KN and 97 bar respectively, while the nominal combustion time is about 104 s.
The movable nozzle is operated by a **T**hrust **V**ector **C**ontrol (**TVC**) system that uses Electro-actuators specifically developed for this motor. The actuators operates on a 270 Vdc electric supply, provided by 2 thermal batteries mounted in the rear skirt (0 / 1 Interstage), attached to the bottom of the SRM.

In addition to the motor, the first stage is also composed of the structural elements needed to connect it to the upper stage (1/2 Interstage) and to the ground (0 / 1 Interstage), where the stage avionics components are located.

The 0 / 1 Interstage (rear skirt) is a structure of 1 m high, attached to the bottom of the motor, that interfaces the bearing table of the ground Transporter / Launcher (movable Launch Table).
It has also the role to house the TVC components, including the two Electro-actuators, the relevant **P**ower **D**istribution **U**nit (**PDU**) and thermal battery(s), but excluding the TVC local controlling unit or EPEV (located on the 1 / 2 Interstage).

All the components carried internally to the 0/1 Interstage are accessible from large openings placed below the bearing plane placed at the Launch Pad.

The 1 / 2 Interstage, which is part of the 1 st stage at the state of delivery (Ground configuration), is a conical structure with a 14.5° semi-apex angle, 2138 mm high.

It has the role to house:

- The 1 st Stage EPEV (local TVC control box),
- The components of 1 st Stage Safety Subsystem, including:
  - the local **S**afety **R**emote **U**nit (**SRU**),
  - the relevant two batteries,
  - the Safety **S**afe and **A**rm **D**evice (**SAD**) and
  - the double 1 st Stage Destruction Pyro-Chain,
- The n° 4 Retro Rocket motors and relevant Ignition Pyro-Chain, including relevant Safe and Arm Device,
- The 1 st Stage Ignition Pyro-Chain, including relevant Safe and Arm Device,
- The 1 st Stage Separation Pyro-Chain, including relevant Safe and Arm Device.

The Separation Pyro-Chain is based on a Linear Cutting Charge.

The separation plane is on the 1 / 2 Interstage, 622 mm below the stage upper interface plane (X = 10846 mm from the Origin).

In addition, on the 1 / 2 Interstage, dedicated doors allow accessibility to the above listed 1 st Stage components, and to access to the 2 nd stage TVC components, placed under the 2 nd Stage motor.

1.3.1.2 The Second STAGE.

The VEGA Launch Vehicle second stage, is based on a stretched version of the ZEFIRO 16 SRM, already qualified, with a propellant mass increased up to 23.8 tons.
The stage is 8.9 meters long (overall length, including nozzle extension), with a 1908 mm outer diameter (the maximum external diameter on flanges is 1944 mm).

The new stretched ZEFIRO SRM is named **ZEFIRO 23** and employs:

- A light weight carbon-epoxy case,
- A low density EPDM based thermal insulation, charged with glass microspheres,
- A HTPB 1912 composite propellant,
- A moving nozzle, based on the flexible joint technology, with a geometric deflection capability of 7 deg.

Polar fittings and interstage flanges are made of high strength aluminium forging.

The propellant grain has a finocyl shape, with the star section in the aft zone of the motor near to the maximum polar opening. The star shaped section consists of a conventional star, with a 3D-transition region coupled to the cylindrical region.

ZEFIRO 23 SRM maximum vacuum thrust and pressure are 1200 kN and 95 bars, respectively.
The nominal burning duration of the second stage is about 71 seconds.
The nozzle throat diameter is 294 mm and the expansion ratio S is about 25.

The nozzle deflection is driven by the second stage TVC system, that is composed of:

- A local electronic control box, named **EPEV** (**E**lectro-**A**ctuators **P**iloting **E**quipment **V**EGA),
- Two Electro-actuators providing force to the nozzle for its deflection (and elongation feedback signals to the EPEV), that includes a **P**ower **D**istribution **U**nit (**PDU**),
- 4 thermal batteries (or 1 according to Supplier choice), and relevant harnesses.

TVC components are placed under the ZEFIRO 23 SRM, except the EPEV, placed inside the 2 / 3 Interstage.

The second stage is also composed of a structural section (2 / 3 Interstage) to connect it to the 3 rd stage and to locate the avionics.
This 2/3 interstage airframe is an aluminium shell, 1.63 m high, with riveted stiffeners on the inner side.

It also includes a pyrotechnic separation system based on a Linear Cutting Charge (similar to the one foreseen for the Interstage 1 / 2). The separation plane is located 510 mm below the stage upper interface plane (X 0 20265 mm).

Dedicated doors allow accessibility to all the 2 nd Stage Safe and Arm Devices, to the Safety batteries and to access the 3 rd stage TVC components (when the LV is on the Launch Pad).

1.3.1.3 The Third STAGE.

The VEGA Launch Vehicle third stage propulsion is based on a Solid Rocket Motor with a propellant mass of 9 ton (ZEFIRO 9 SRM), strictly derived from ZEFIRO 16 SRM.

The stage overall length is 4.12 m (overall length, including nozzle extension) and its typical diameter is 1904 mm (the maximum external diameter on flanges is 1944 mm).

It employs a carbon-epoxy filament wound case, a low density EPDM based thermal insulation, HTPB 1912 composite propellant (as the P80 FW SRM, but with a different Ammonium Perclorate distribution to allow a different burning velocity) and a moving nozzle based on the flexible joint technology.

ZEFIRO 9 SRM maximum vacuum thrust and combustion pressure are 280 KN and 67 bars, respectively.

SRM ignition occurs after a coasting phase of several seconds (according to the required trajectory), after a ZEFIRO 23 burnout.

Nominal SRM combustion duration is about 117 seconds.

The nozzle throat diameter is 164 mm and the expansion ratio Σ is 56.

The nozzle incorporates a flexible joint with a geometric deflection angle of 6 deg, driven by the third stage TVC, that is composed of :

- A local electronic control box (EPEV),
- Two Electro-actuators providing force to the nozzle for its deflection and elongation feedback signals to the EPEV, including its own PDU,
- A thermal battery,
- The harnesses.

TVC components are placed under the ZEFIRO 9 SRM, except EPEV, placed inside the 3/AVUM Interstage.

This stage is also composed of the 3 / AVUM Interstage airframe, which interfaces the SRM with the 4 th stage (AVUM) and where the remaining 3 rd stage avionics components are located, including the most of the Safety Subsystem.

The 3 / 4 interstage is a cylindrical aluminium shell with integrated stiffeners on the inner side, 820 mm high.

Two different antenna sets are placed on its external surface:
- A set of antennae for the Radio-Destruct Receiver (RTX);
- A set of antennae for the radar transponder (TR).

Dedicated doors allow the necessary accessibility to equipment's when the LV is on the Launch Pad.

The stage upper interface is also the separation plane with the AVUM.
The separation system is based on a Mechanical clamp-band, released by Pyro-bolts.

1.3.1.4 The AVUM

The **AVUM** (**A**ttitude and **V**ernier **U**pper **M**odule) is made of two different sections, one for the allocation of the propulsion elements (**A**VUM **P**ropulsion **M**odule or **APM**) and the second one dedicated to the electronic components located on the upper stage (**A**VUM **A**vionics **M**odule or **AAM**).

The AVUM propulsion fulfils the following functions :

- A Roll control during the 3 rd and 4 th stage flight,
- An Attitude control during coasting phases and in orbit flight,
- A Correction of axial velocity error due to SRM's variance,
- A Delta velocity for circularization,
- A Satellite pointing,
- Payload(s) release maneuvers,
- An Empty Module de-orbiting.

The AVUM propulsion is provided by :

- A bi-propellant **L**iquid **P**ropulsion **S**ystem (**LPS**) using as **M**ain **E**ngine (**ME**) the YUZHNOYE RD869 engine), with a regulated pressure feeding system, set to provide a thrust of 2450 N and a nominal specific impulse of 315.5 s.
  The engine is mounted on a gimbal and oriented by two Electro-actuators.
  It uses **N**itrogen **T**etr-**O**xide (**NTO**) as oxidizer, stored in two metallic tanks, 98 liters each, and **U**nsymmetrical **D**i-**M**ethil **H**ydrazine (**UDMH**) as fuel, stored in a single 177 liters metallic tank.

The Main Engine is capable of at least 5 ignitions; in a nominal flight with a single Payload only three firing sequences are foreseen (i.e. three ignitions):

- The main boost phase (to reach the required delta velocity),
- The Orbit circularization,

Both propellants are fed by gaseous Helium contained in a single 53 liters HP composite gas vessel (MEOP 300 bars).
The three propellant tanks are pressurized at 6 bar maximum when on ground and till the LPS activation (36 bar MEOP after LPS activation).
The pressure drop between the high pressure and the low pressure is obtained by means of a **G**as **P**ressure **R**egulator (**GPR**).

The total propellant loading will range between 250 and 370 Kg (up to 123 Kg UDMH and 247 Kg NTO), depending on the mission to be performed.

A cold gas (GN2) **A**ttitude **C**ontrol **S**ystem (**ACS**) with two clusters composed of three thrusters, each having a thrust of 50 N, fed by a single 53 litters vessel (MEOP: 300 bar).

It is planned to use the same vessel as the one chosen to pressurize the propellant tanks.
The AVUM structure, that is composed of :

- a cylindrical frame, 465 mm high, with a 1925 mm diameter,
- two vertical panels supporting the tanks,
- two half-moon shaped platforms where the centralized part of the LV avionics is accommodated.

The total height of the AVUM is 1685.5 mm.

1.3.1.5 Avionics for VEGA Launch Vehicle

Hereafter a quite short description of the Avionics is given for reader's convenience.
Most of the VEGA Avionics equipment are housed on the **A**VUM **A**vionics **M**odule (**AAM**), except :

- The TVC electronics (EPEV, Actuators with relevant PDU's, thermal batteries…)
- The Safety Subsystem: main part of the Safety Subsystem is placed on the 3 rd stage (for functional and mass budget reasons); while the local electronic boxes (**S**afety **R**emote **U**nits or **SRU**) are located on 1 st and 2 nd stages. No Safety Subsystem components are located on the AVUM.

The lay-out of the AVUM Avionics Module has been defined so that electronic equipment are de-coupled from the cylindrical structure (APM structure) that directly transfers the thrust to the Payload, in order to avoid interactions between Payload behavior and inertial sensors.

The avionics architecture is simplex (no redundancy), except for the Safety Subsystem that is redounded (moreover any other component relevant to safety aspects is fully redounded).

Main Avionics Subsystems are **:**

Flight Control Subsystem, (later also indicated as **G**uidance, **N**avigation and **C**ontrol Subsystem or **GNC**) : the LV guidance, navigation and control function is performed by an **O**n-**B**oard programmed flight **C**omputer (**OBC**), which executes the navigation calculations and implement the guidance law. This function is performed with the aid of an **I**nertial **M**easurement **U**nit (**IMU**) which delivers navigation and attitude data to the computer.

The computer calculates the attitude deviation as difference between the actual attitude and the required attitude (due to guidance or to control needs) and generates the deflection commands to Stage TVC's.

These commands are transmitted to the local electronic box (**E**lectro-actuators **P**iloting **E**quipment **V**ega or **EPEV**), relevant to the acting (burning) stage in order to deflect the thrust vector into the appropriate direction.

Sequential commands (SRM ignitions, stage separations, valves and pyro- commands, etc.) from OBC are processed by a single **M**ulti-**F**unctional **U**nit (**MFU**) placed on the AAM and transmitted to the relevant hardware on the appropriate stage.

Telemetry Subsystem : it transmits to the ground the on-board measurements monitored during the flight :

- Up to 120 differential analog channels;
- Up to 160 bi-level channels.

This system reuses hardware coming from ARIANE 5 development (antennas, and transmitter) or partially found on the international market for similar application (when economically opportune).

Power Supply Subsystem : the main on-board electrical energy sources are constituted by:

- A Battery for all Pyrotechnic uses (or "Pyro Battery"), placed on the AVUM,
- A so called "functional" Battery (or On Board Battery), placed on the AVUM :
  - for Guidance, Navigation & Control needs,
  - for telemetry uses,
  - to power up the local EPEV on each Stage,
  - to power up the TVC Electro-actuators for AVUM Main Engine deflection
- Three Batteries (one per each SRM, at different Voltage levels) to power up the Electro-actuators of relevant Stage TVC's.

It has to be noted that Safety Subsystem Batteries (two on each solid stage) are totally independent from the Power Supply Subsystem (they belong to the Safety S/S).

Safety Subsystem : is completely doubled and its functions are :

- The LV destruction in case of safeguard necessity and
- Crack-opening of the motor cases after nominal separation,
- To contribute to the LV localization during flight.

These functions are managed through:

- A **S**afety **M**aster **U**nit (**SMU**),
- The **S**afety **R**emote **U**nits (**SRU**) on each stage,
- The Radio - destruction receivers (RTX) and relevant antennas (ATD),

- The **R**adar **T**ransponders (**RT**) and relevant antennas (ATJ).
- The Safety Batteries on each solid Stage.

1.3.1.6 Payload compartment configuration

VEGA Launch Vehicle is capable to launch payloads within the envelope volume defined in § 4.5.4.

Single launch is the master configuration (allowable masses and inertia are reported in figure 4.1); however other configurations can be analyzed:

- The launch of a main satellite and up to three micro-satellites (TBC.), those being mounted on a platform fixed to the adapter frame;

- A cluster launch for micro-satellites using a dispenser, to be developed.

The description of the fairing main parts together with the adaptors are given herafter:

T.B.D.

This architecture allows the encapsulation of the payload independently from the launch vehicle itself.

TBD

Figure 1.1 Expanded View of VEGA Launch VEHICLE

TBD

Figure 1.2 VEGA Payload Compartment configuration

Chapter 2
General Performance Data

General Performance Data Chapter 2

2.1. INTRODUCTION

This section provides the information necessary to make preliminary performance assessments for the VEGA launch vehicles.

This document is a guide for mission design, and predictions are presented with a slight degree of conservatism to make sure that the launch vehicle will meet the expectations.

Beyond these performance figures, customized and innovative methods and solutions can also be proposed to Customers, to individually optimize their mission or even increase the launch vehicle standard capability.

This section describes the orbital performance capabilities of the VEGA Launch Vehicle.

2.2. MISSION PERFORMANCE

Performance is expressed in terms of payload mass and is based on the following assumptions :

- Launch from the CSG (French Guyana), taking into account the relevant safety requirements;
- Fourth stage carrying sufficient propellant to reach the intended orbit with a 99 % probability;
- At Fairing jettison, the aerothermal flux is lower than 1135 W/m 2 ;
- Altitude values are given with respect to a spherical earth of 6378 km radius.

The mission performance includes the mass of:

- The spacecraft(s),
- The adaptors or dispensers: adaptors masses are defined in the appendices,

The VEGA Launch Vehicle is capable of several missions in circular orbits ranging from:

- Altitude: 300 Km to 1500 Km, with
- Inclinations from 5.2° to Sun Synchronous.

On reference orbits, and supposing a launch at the optimal time, the performance is :

- Polar orbit : Inclination of 90° with 700 Km circular Altitude : 1500 Kg

The performance map is shown in Figure 2.1.

A Typical Ground Track is given in Figure 2.2.

2.3. INJECTION ACCURACY

VEGA Launch Vehicle injection accuracy standard (1 sigma value) are better than :

- 10 Km on Altitude,
- ± 0.05° on Inclination,
- ± 0.1° on Ascending Node.

2.4. MISSION TIMELINE

Figure 2.3 gives typical flight chronograms for the reference missions.

2.5. SPACECRAFT ORIENTATION AND SEPARATION

After injection into the desired orbit, the launch vehicle cold gas attitude control system provides the required orientation and spin to the spacecraft before its separation. After completion of the separation(s), the fourth stage is sequenced to carry out a maneuver to avoid subsequent collision and then de-orbited.

The following performances are to be considered for the main passenger, mounted on top of the adaptor.
It is possible, on Customer's request, to adapt the S/C orientation depending on the real time of lift-off.

2.5.1. Orientation performances

The desired orientation at separation should be specified by the User with respect to the following system of axes :

u : radius vector with its origin at the center of the Earth and passing through the intended orbit perigee, u will cross the S/C Center Of Gravity
v : perpendicular to u in the intended orbit plane, having the same direction as the perigee velocity,
w : perpendicular to u and v, such that (u, v, w) form a direct trihedron.

For circular orbit, the [U, V, W] frame is intended related to the orbit at a reference time (specified in relation with the mission characteristics) with U defined as radius vector with origin at the earth center and passing through the launcher **C**enter **O**f **G**ravity (**COG**) and V, W as defined above.

In case of 3-axis stabilized mode, 2 of the 3 spacecraft axes [U, V, W] co-ordinates should be specified.
In case of spin stabilized mode, the spacecraft spin axis [U,V,W] co-ordinates should be defined.

2.5.2. Spin-up performance

The roll control system can provide a spin rate lower than or equal to 5 r.p.m. clockwise or counter-clockwise.

2.5.3. Spacecraft pointing accuracy

For three-axis or spin-up stabilized conditions, pointing accuracy immediately after separation, at a 99 % probability level, is better than :

- 3-Axis stabilized attitudes:
  ± 1.0° on geometric axis pointing (pitch, yaw)
  ± 0.6°/s on transverse velocity (pitch, yaw)
  ± 1.5° on roll angle and ± 1°/s rate

- spin stabilized conditions:
  < 5.0° on nutation with spin speed = 5 rpm
  ± 1.0°/s on roll rate.

2.5.4. Separation velocities

Payload separation system is designed to deliver a minimum relative velocity of 0.5 m/s between the two separated bodies in order to avoid collision risk between the Launch Vehicle and the Spacecraft.

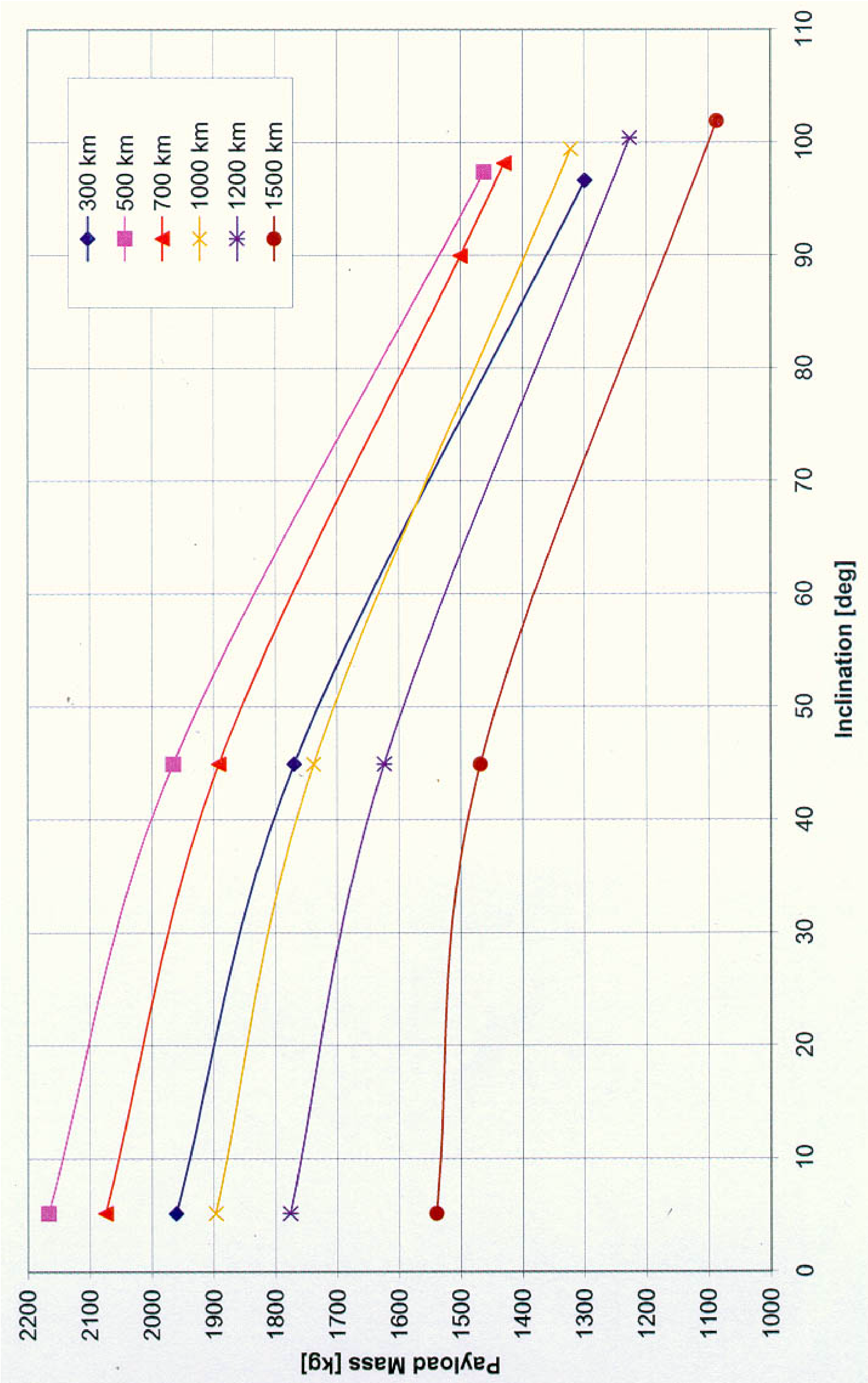


Figure. 2.1 – Performance map

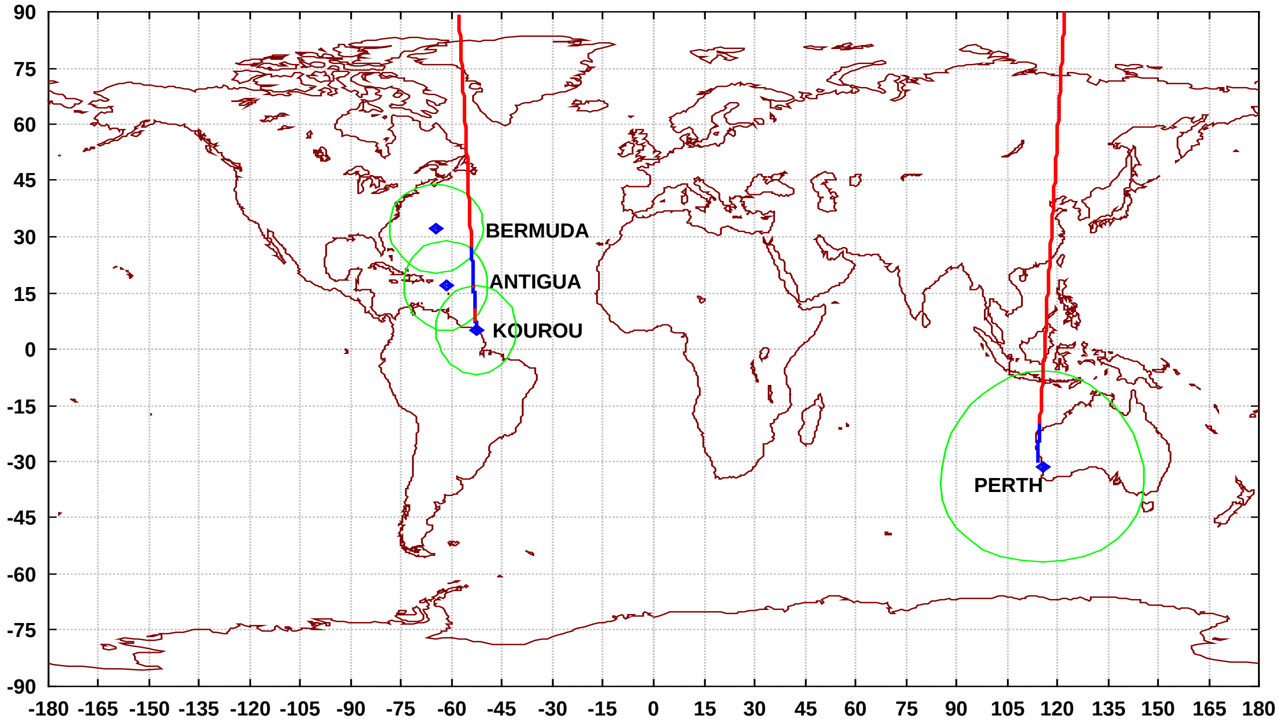


Figure. 2.2 – Typical Ground Track

REFERENCE TRAJECTORY (700 km, PEO)
Target Payload: 1500 kg; Effective Payload: 1653 kg
(Nominal, considering scattering compensation margin)

Time	Event	Referenced Time
H0	First irreversible order : P80 FW ignition Lift off P80 FW propelled flight time	0 s 104 s
H1	P80 FW burnout First stage separation command Zefiro 23 ignition command Zefiro 23 propelled flight time	≈ H0 + 104 s H1 = H0 + 104 s + 0 s H1 ± 0 s 70 s
H2	Zefiro 23 burnout First Coasting phase Second stage separation command Second Coasting phase Fairing jettisoning command Zefiro 9 ignition command	≈ H1 + 70 s =174 s 0 s ***H2 ≈ H1 + 70 s =174 s*** 64 s (in general 50s - 100 s) TLF ≤ H2 + 20 s H2 + 64 s
H3 **H4**	Zefiro 9 burnout Third stage separation command As necessary : First AVUM ignition command AVUM propelled flight in order to reach the required transfer orbit	≈ H2 + 117 + 64 s ***H3 = H2 + 117 + 64 s*** H3 + 1 s (TBC) 1 st AVUM boost duration = 202 s
H4.1 **H4.2**	First cut-off command to AVUM Coasting phase AVUM ignition command for orbit circularization	***H4.1 = H3 +203 s*** T ballistic flight = 2658 s ***H4.2 = H4.1 + 2658 s***
H4.3	Cut-off command to AVUM Upper composite orientation	***H4.3 = H4.1 + 2658 + 181 s***
H5	Payload separation command AVUM ignition command for AVUM de-orbiting	***H5 = H4.2 + TBD***
H6	End of mission, the Launch Vehicle gives the last order for de-orbiting burn and passivation	H5 + TBD

Figure 2.3. : Typical Chronology for Reference Mission

Chapter 3
Environmental conditions

Environmental Conditions Chapter 3

General

Two phases have to be considered :

- **The ground phase** comprising :
  - The spacecraft preparation phase within the EPCU buildings, and transport between these buildings,
  - the pre-launch phase while the spacecraft is encapsulated inside the Fairing, and mated to the launch vehicle.

- **The in-flight phase**.

3.1. GROUND PHASE ENVIRONMENT

3.1.1. Mechanical environment

3.1.1.1. Quasi-static acceleration

During all ground phases, the quasi-static acceleration on the payload will not exceed the on flight limitations (§ 3.2.1.2.).

3.1.1.2. Acoustic

The noise level generated by the ventilation system will not exceed the in flight limitations (§ 3.2.1.6.).

3.1.2. Thermal environment

During all the operations in the EPCU, the payload is in a standard environment (clean air and regulated temperature), described in the EPCU manual.

When mated to the launch vehicle, the spacecraft is protected by an air-conditioning system provided by ventilation through the pneumatic umbilical (see figure 3.7).
The air inlet temperature shall be adjustable between 13 °C and 25 °C.
The **R**elative **H**umidity (**RH**) during these operations is : TBD

3.1.3. Static pressure

Main air velocity within the fairing is lower than 2 m/s (but locally, near air inlet, the velocity may exceed this value).

3.1.4. Cleanliness & contamination

During all ground phases, the clean rooms in EPCU buildings does not generate organic deposit exceeding 2 mg/m 2/ week.
The ventilation system is compatible with class 100,000 cleanliness.

3.1.5. Electrical & electromagnetic environment

The Launch Range electromagnetic environment of the CSG is defined in the relevant applicable Satellite **I**nterface **C**ontrol **D**ocument (**ICD**).

3.2. IN FLIGHT PHASE ENVIRONMENT

3.2.1. Mechanical environment

3.2.1.1. General

During flight, the payload is subjected to static and dynamic loads induced by the launch vehicle.

Lift-off and in-flight excitations may be of aerodynamic origin (wind, gust, buffeting, etc.) or due to the propulsion systems (longitudinal acceleration, thrust build-up or tail-off transients, etc.).

The loads defined in the following paragraphs should be considered as flight limit loads applying to the spacecraft.

The related probability of these figures not being exceeded is 99 %.

The coordinate axes of the launch vehicle are presented in figure 3.1.

The spacecraft base is defined at the interface between the L/V and S/C.

3.2.1.2. Steady state acceleration and Quasi-Static Loads (QSL)

Figure 3.2 shows typical longitudinal static acceleration time histories.
The peak acceleration will not exceed 5.5 g for a payload above 600 kg; for a payload below such a figure specific assessment shall be made depending on mission details.

Highest static lateral acceleration is 1 g.

During lift-off and in-flight phases, static acceleration and low frequency dynamic accelerations combine to issue the **Q**uasi-**S**tatic **L**oads (**QSL**), which reflect the mechanical fluxes at the launcher / payload interface:

- $\Phi_{longi} = M_{sat} \cdot QSL_{longi} \cdot g \, / \, (\pi \cdot D_{I/F})$
- $\Phi_{lat} = 4 \cdot M_{sat} \cdot QSL_{lat} \cdot g \cdot X_{sat} \, / \, (\pi \cdot D^2_{I/F})$

where: M_{sat} = Satellite mass,
$D_{I/F}$ = Interface Diameter,
X_{sat} = Centre Of Gravity position on longitudinal axis w.r.t. interface plane

The design and dimensioning of the primary structure must therefore allow for the most severe load combination that can be encountered at any instant of flight.

Flight limit loads are given in the table 3.1.

Acceleration (g)	**Longitudinal**		**Lateral**
Flight event	Static	Dynamic	Static + Dynamic
Lift-off	- 2.00	± 1.50	± 1.00
P 80 flight	- 5.30	± 1.00	± 1.00
Z 23 flight	- 6.00	± 1.00	± 1.00
Z 9 flight	- 5.00	± 1.00	± 1.00

Note: The minus sign with longitudinal axis indicates compression,
Lateral loads may act in any direction simultaneously with longitudinal loads.

Table 3.1 : Flight limit loads (QSL)

3.2.1.3. Low frequency longitudinal vibrations

The sinusoidal vibration level at the base of the spacecraft is lower than 1 g in the frequency range from 2 to 100 Hz (figure 3.3).

This spectrum envelopes all sinusoidal vibrations and sine equivalent (Q = 20) of transients in this bandwidth.

3.2.1.4. Low frequency lateral vibrations

The sinusoidal vibration level at the base of the spacecraft is lower than 1 g in the frequency range from 2 to 100 Hz (figure 3.3).

This spectrum envelopes all sinusoidal vibrations and sine equivalent (Q = 20) of transients in this bandwidth.

3.2.1.5. Random vibrations

Random vibrations are generated by combustion phenomena or structure vibroacoustic responses. Such vibrations are transmitted to the spacecraft via the L/V structure.
The RMS level in the range [20-2000 Hz] will not exceed 5 g (see figure 3.4).

3.2.1.6. Acoustic vibrations

Engine acoustic radiation and aerodynamic turbulence of the aerodynamic flow, transmitted through the fairing structure induce acoustic noise inside the fairing.

The level is the highest at lift-off and in the transonic/Qmax region.
It is substantially lower outside of these periods.

The envelope of acoustic noise during flight is shown on figure 3.5.
The RMS level in the range [20-2000 Hz] will be lower than 142 dB.

It depends on the spacecraft volume (fill factor) and its acoustic absorption characteristics. For spacecraft volume higher than 10 m^3 , a 3 dB increase of the acoustic level in the 31 and 63 octave bands should be considered (TBC)

It is assessed that the sound field inside the fairing is diffuse.

3.2.1.7. Shocks

The spacecraft is subjected to shocks, principally during its separation from the L/V and during fairing jettison.

The induced level on the S/C interface ring with the L/V will not exceed the **S**hock **R**esponse **S**pectra (**SRS**) [**SRS** - Q = 10] presented on the figure 3.6.

These levels are exerted in both axial and radial directions.

3.2.2. Thermal environment

3.2.2.1. In-flight temperature under the Fairing

The net flux density radiated by the fairing does not exceed 1000 W/m^2 at any point.

3.2.2.2. Aerothermal fluxes at fairing jettisoning

The nominal time for jettisoning the fairing on all flights is determined in order to not exceed the aerothermal flux of 1135 W/m^2 .

This flux is calculated as : $F = ½ \rho V^3$ (free molecular flow – atmosphere US 66, latitude 15° North).

Solar-radiation flux, albedo and terrestrial infrared must be added to this aerothermal flux.

3.2.2.3. Thermal flux from stage separation

Thermal fluxes from stage separation do not affect the payload.

The Thermal impingement due to the third stage firing shall be prevented by means of suitable thermal protections, launch vehicle side.
On a case by case basis, local interfaces with the S/C shall be required in order to apply, if necessary, additional thermal protections, removable at S/C separation.

3.2.3. Static pressure

The static pressure evolution within the fairing is shown in the figure 3.10.
The typical slope is 20 mbar/s during ascent phase.
At fairing separation, the maximum pressure differential over ambient will be 100 mbar.

3.2.4. Contamination and cleanliness

From the beginning of its encapsulation up to its separation from the launcher, organic deposits on the spacecraft will not exceed 2 mg/m^2/week.

3.2.5. Radio and electromagnetic environment

In order to ensure the radio compatibility between the Launch Vehicle and the spacecraft, a frequency plan is drawn up for each launch.
The User is required to supply all the data needed for its preparation.

On the Launch Vehicle side, the radiation characteristics of the **T**ele**M**etry (**TM**), **T**ele**C**ommand-Destruction reception (**TC**) and **T**ra**J**ectography transponder (**TJ**) systems are the following :

- **TM** : 2200 - 2290 MHz band / 8 W
- **TC** : 400 - 500 MHz band
- **TJ** : 5400 – 5900 MHz band / 400 W peak (pulse with 0.5 :1.7 μs)

Spurious radiation interference levels from the Launch Vehicle will not exceed:

- 90 dBμV/m in the 14 kHz to 18 GHz band,

except in the following bandwidth:

- 35 dBμV/m in the 2.025 GHz to 2.11 GHz band,
- 145 dBμV/m in the 2.2 GHz to 2.9 GHz band,
- 145 dBμV/m in the 5.4 GHz to 5.9 GHz band,
- 45 dBμV/m in the 5.925 GHz to 7.075 GHz band,
- 55 dBμV/m in the 14 GHz to 14.8 GHz band.

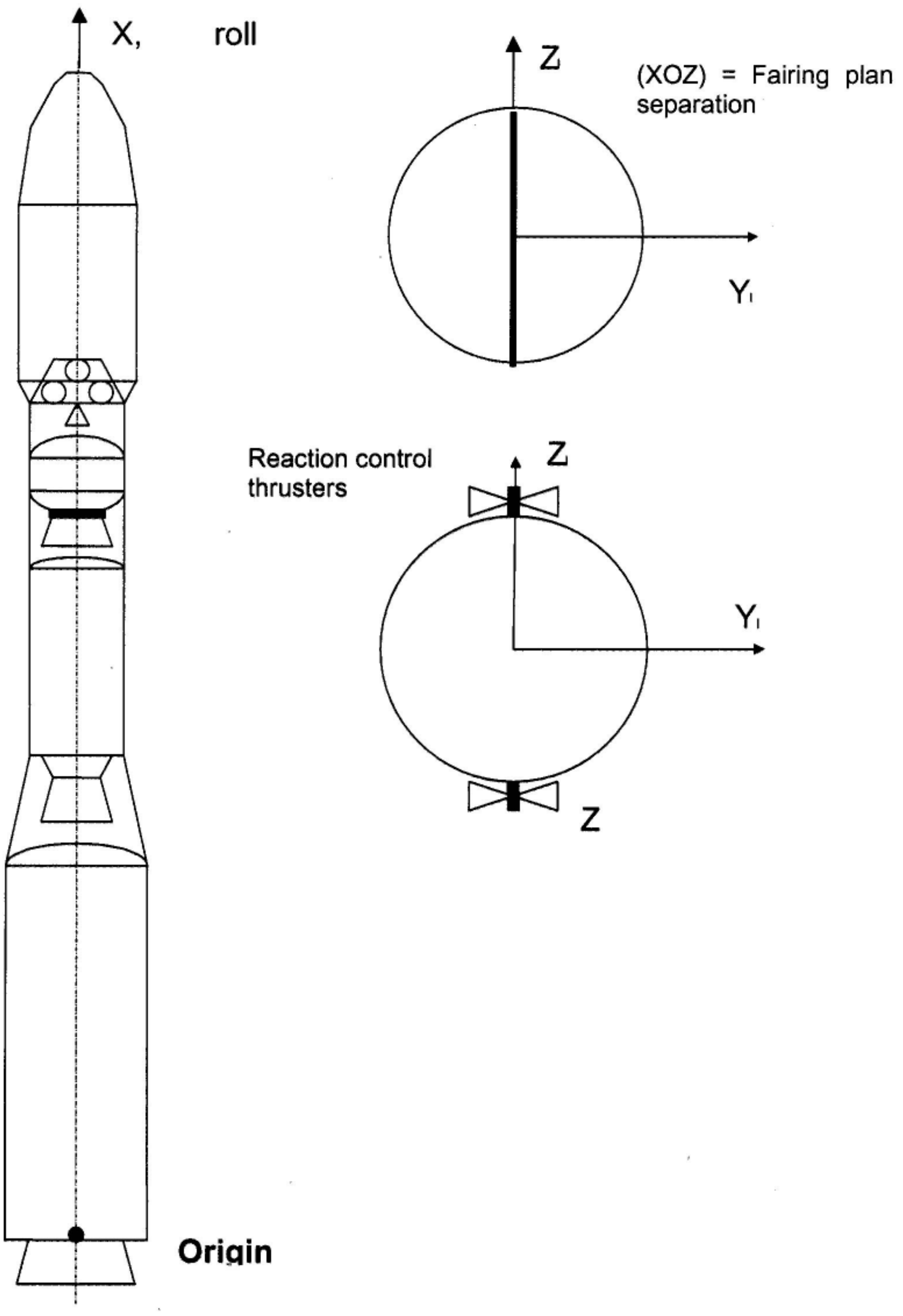


Figure 3.1 : Launch vehicle geometric reference frame

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Figure 3.2 : Longitudinal static acceleration profile versus time.

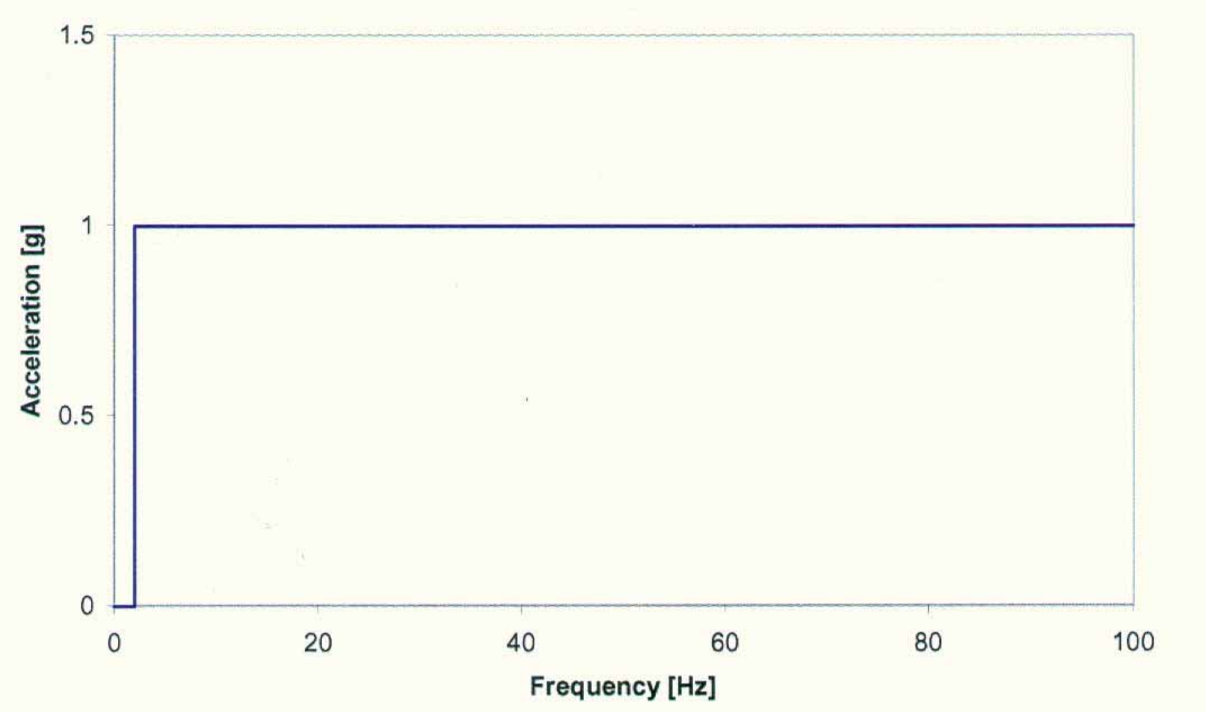


Figure 3.3 : Longitudinal and lateral vibrations limits

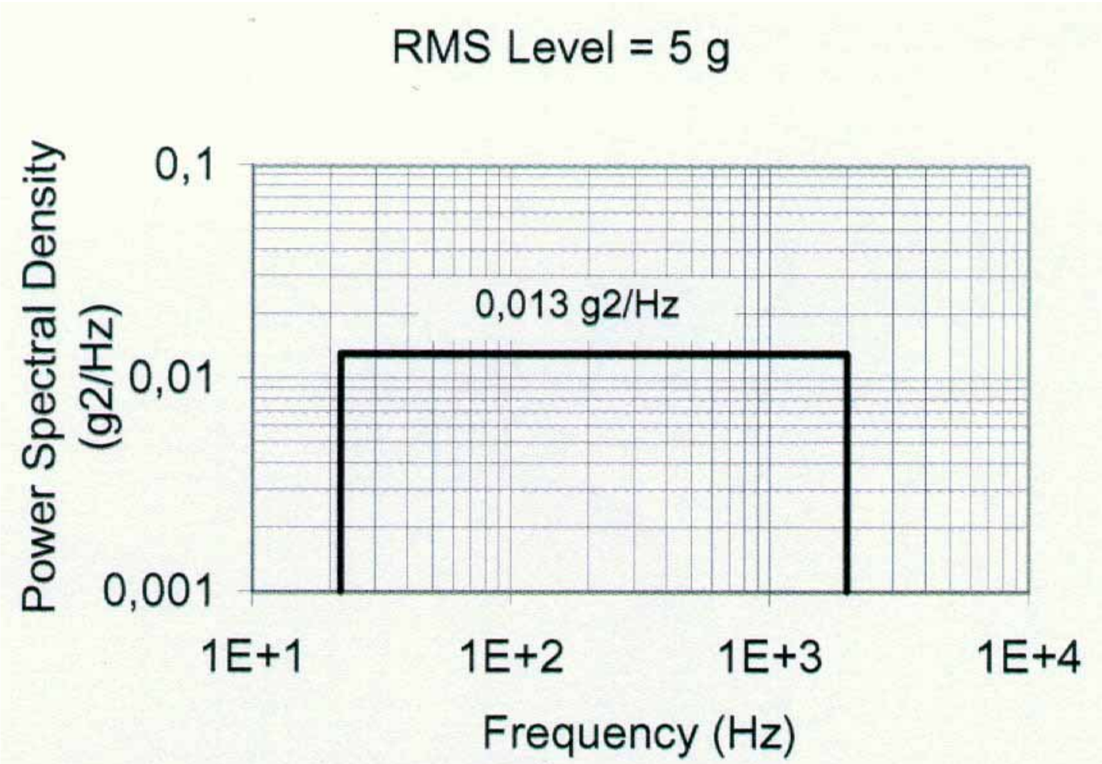
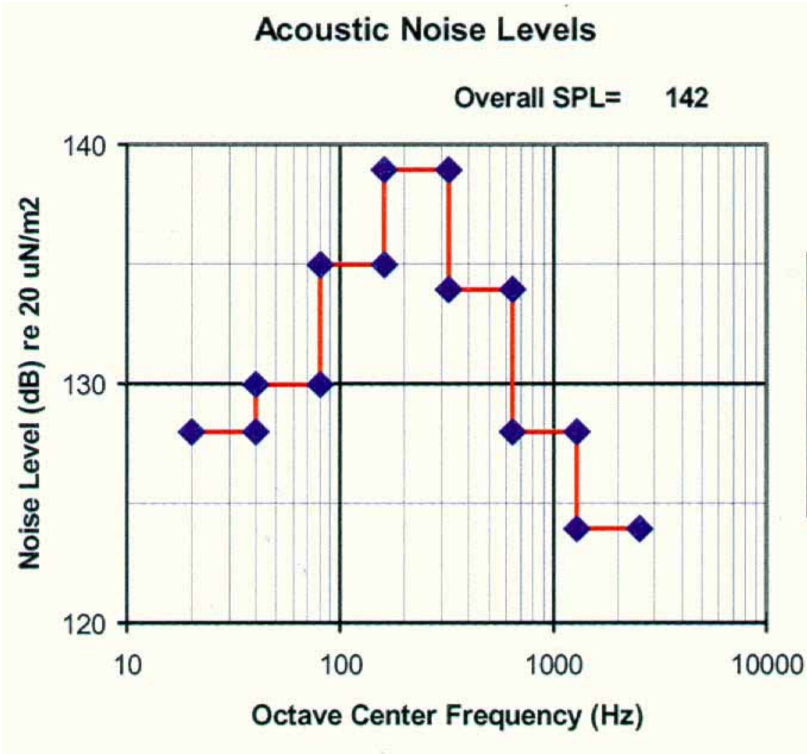
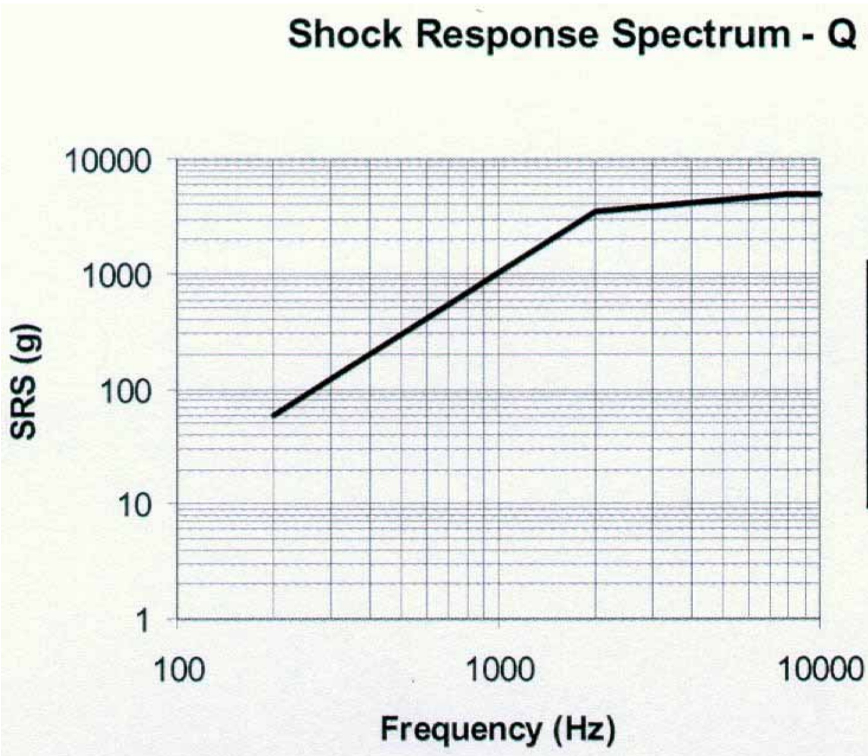


Figure 3.4 : Random Vibrations



Octave [Hz]	SPL[dB]
31.5	128
63	130
125	135
250	139
500	134
1000	128
2000	124

Figure 3.5 : Envelope of acoustic spectrum



Freq. [Hz]	SRS [g]
200	60
2000	3500
8000	5000
10000	5000

Figure 3.6 : Maximum SRS (Q = 10) on the Spacecraft interface ring with the launch vehicle

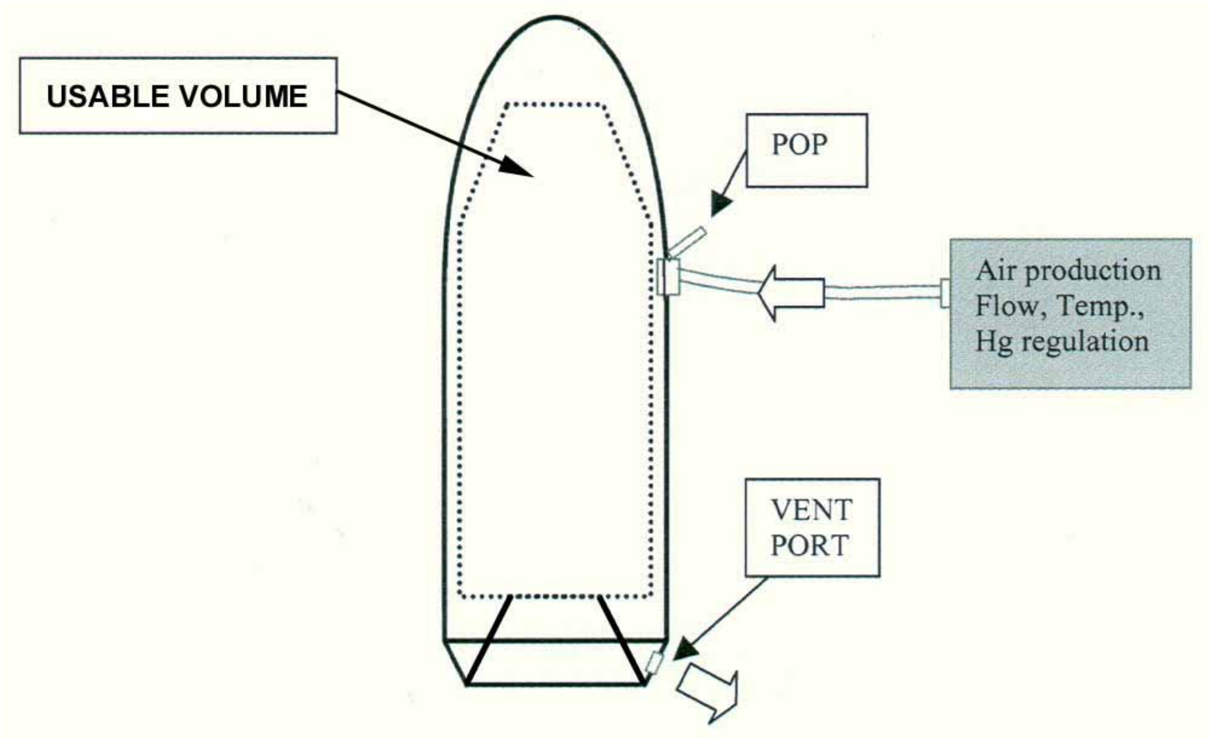


Figure 3.7 : Representation of the ventilation of fairing

T.B.D.

Figure 3.10: Static pressure within the fairing.

Chapter 4
Spacecraft Design and Dimensioning Data

Spacecraft Design and Dimensioning Data — Chapter 4

4.1. INTRODUCTION

The design and dimensioning data, that shall be taken into account by any User intending to launch a spacecraft compatible with VEGA vehicle, are detailed in this chapter.

4.2. SAFETY REQUIREMENTS

The User is required to design the spacecraft in conformity with the CSG Safety Regulations.

4.3. SELECTION OF SPACECRAFT MATERIALS

The spacecraft materials must satisfy the following outgassing criteria :

- Total mass loss $\leq$ 1 %
- Volatile condensable material $\leq$ 0.1 %

measured in accordance with the method described in the ESA PSS-01-702 specification.

4.4. DIMENSIONING

4.4.1. Spacecraft balancing

4.4.1.1. Static unbalancing

The maximal distance of the **C**enter **O**f **G**ravity (**COG**) with respect to separation plane depends on the Spacecraft mass.
The limits for the lateral offset of COG Dynamic unbalancing and for the ε angle, corresponding to the angle between the spacecraft longitudinal geometrical axis and the principal roll inertia axis, are reported in the tables 4.1.a / b / c.

4.4.1.2. Inertia ratio

The ratio λ of the transverse inertia momentum on the roll inertia momentum should be checked comprised between the limits reported in the tables 4.1.a / b / c.

4.4.2. Frequency requirements

To avoid coupling between the low frequency dynamic of the launch vehicle and spacecraft modes, the Spacecraft should be designed with a structural stiffness which ensures the following frequency requirements :

- Lateral frequencies $\geq$ 15 Hz
- Longitudinal frequencies $\geq$ 35 Hz

This assumes a spacecraft hardmounted at the separation plane.

4.4.3. Dimensioning loads

For spacecraft complying with the previous frequency and balancing requirements the design and dimensioning of the primary structure must allow to the most severe load combination from those defined in Chapter 3 (table 3.1), taking into account minimum safety factors of 1.1 at yield stress and 1.25 at Ultimate stress.

The secondary structures and equipment must be designed to withstand the sine and random environment induced at the base of the spacecraft, as described in Chapter from 3.2.1.2. up to 3.2.1.5.

The coupled load analysis carried out as part of the Mission Analysis will verify the dimensioning adopted with reference to the quasi-static and low frequency loads.

4.4.4. Spacecraft compatibility demonstration

The Spacecraft Authority has to prove that the spacecraft is capable to withstand the flight environment. This justification should be supported by environmental test, based on limit excitations defined in Chapter 2, and taking into account minimum qualification factors and test conditions as defined hereafter :

- Sine environment : qualification factor 1.25
  2 octave/min. sweep rate

- Random vibration : qualification factor 1.25 (2 dB)
  on RMS values, i.e. 4 dB on PSD values
  2 min. duration

- Acoustic noise : qualification factor 1.25 (2 dB)
  2 min. duration

These safety margins and qualification factors intend for demonstrations by tests.
In case of a demonstration supported only by calculations, additional margins (TBD) should be taken into account.

The spacecraft compatibility with shock environment shall be demonstrated using a qualifying separation system or extrapolating SRS values, measured during a nominal clampband release, to the specified spectrum (see § 3.2.1.7).

The minimum qualification factor should be 1.41 (3 dB).

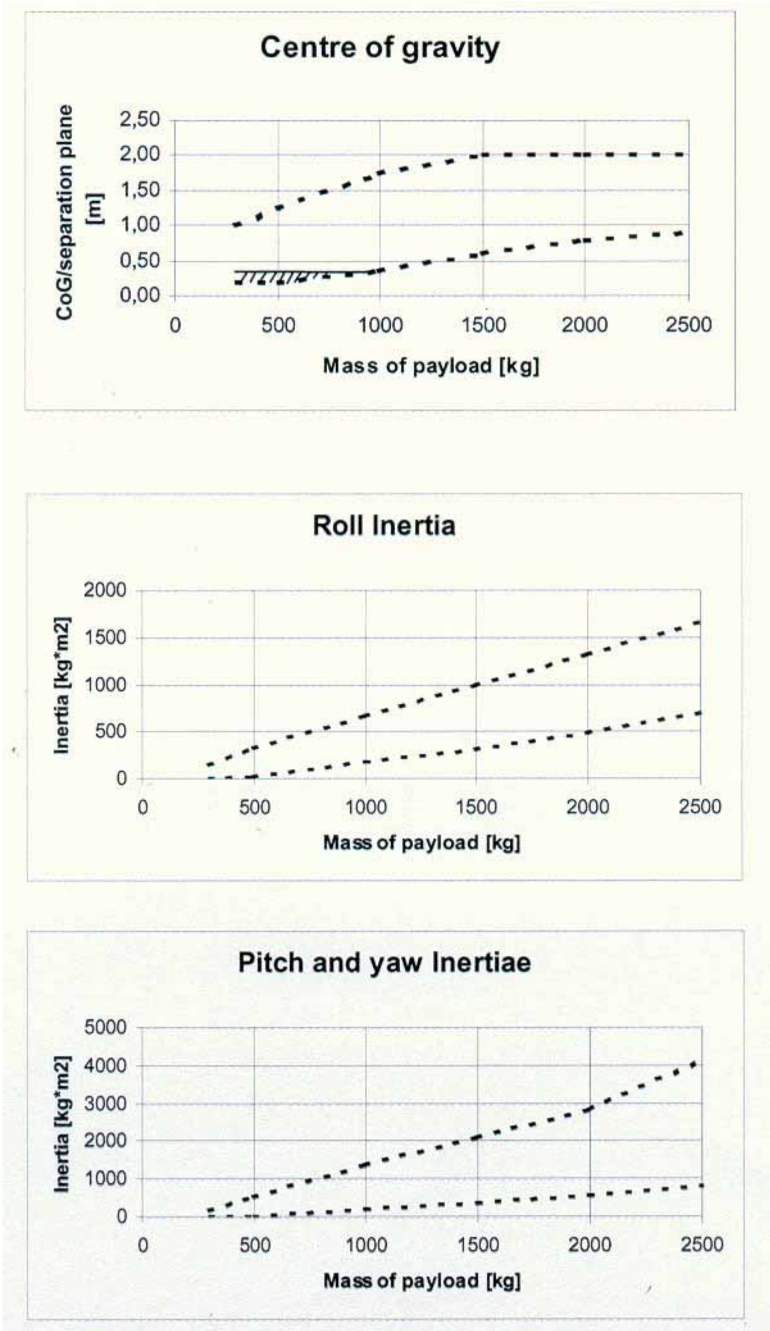
A) SINGLE LAUNCH CONFIGURATION

The allowable masses, COG positions and inertiae for the single launch configuration are the following:

Mass	From 300 Kg to 2500 Kg
Centre of gravity	From 200 mm to 2000 mm (calculated from the separation plane) See fig. 4.1
Static Unbalance (distance "d" between COG of payload and the launch vehicle roll axis)	$d \leq$ 15 mm for spinned payloads $d \leq$ 30 mm for 3 axes controlled payloads
Dynamic unbalance (angle " ε " between principal axes of inertia and launch vehicle roll axis)	$\varepsilon \leq 1°$ for spinned payloads $\varepsilon \leq 6°$ for 3 axes controlled payloads
Ratio λ (ratio between the transversal [pitch] moment of inertia and the longitudinal [roll] one)	$\lambda = It / Ir > 1$ for spinned payloads $0.4 < \lambda = It / Ir < 2.5$ for 3 axes controlled payloads
Roll Inertia	See fig. 4.1
Pitch and Yaw inertia	See fig. 4.1

NOTE: If the payload adopts the separation system provided by the launch vehicle, the payload mass does not include the masses of the elements of the separation system. If the payload provides its own separation system, the payload mass includes the masses of all the elements of the separation system.

Table. 4.1.a MASSES, CENTRE OF GRAVITY POSITION AND INERTIAE (Single Launch)



Note: Dashed area will require additional constraints

Figure 4.1 Single launch configuration – Allowable payload COG and Inertiae.

B) MULTIPLE LAUNCH CONFIGURATION

B.1) DUAL LAUNCH

The allowable masses, COG positions and inertia for the dual launch configuration are the following (see note 1):

Mass Two symmetric or Two non symmetric Payloads Upper Payload Lower Payload	 From 300 Kg to 1000 Kg From 300 Kg to 1000 Kg
Centre of gravity	From 200 mm to 1700 mm (calculated from the separation plane) See figure. 4.1
Static Unbalance (distance "d" between COG of payload and the launch vehicle roll axis)	TBD
Dynamic unbalance (angle " ε " between principal axes of inertia and launch vehicle roll axis)	TBD
Roll Inertia	Values of figure 4.1 limited to 1000 Kg are valid
Pitch and Yaw inertia	Values of figure 4.1 limited to 1000 Kg are valid

Table. 4.1.b MASSES, CENTRE OF GRAVITY POSITION AND INERTIA (Dual Launch)

B.2) MAIN PAYLOAD AND MICRO SATELLITES LAUNCHES.

The allowable masses, COG positions and inertiae for the micro satellites launch configuration are the following (see Note 1):

Mass Main Payload Micro-Satellites (maximum 3)	 From 300 Kg to 2000 Kg < 100 Kg
Centre of gravity	≤ 450 mm (calculated from the separation plane)
Static Unbalance (distance "d" between COG of payload and the launch vehicle roll axis)	TBD
Dynamic unbalance (angle " ε " between principal axes of inertia and launch vehicle roll axis)	TBD
Roll Inertia	≤ 10 m^2.Kg
Pitch and Yaw inertia	≤ 10 m^2.Kg

NOTE: The micro-satellites are allocated on a circular platform externally mounted on the adapter.

Table. 4.1.c MASSES, CENTRE OF GRAVITY POSITION AND INERTIA (Main Payload and Micro-Satellites Launch)

4.5. MECHANICAL INTERFACES WITH THE LAUNCH VEHICLE

4.5.1. Payload compartment configuration

For a single launch, the Spacecraft is mounted, using a clampband, on top of a conical standard adaptor (Ø 1920 mm on base - Ø937 mm on top), and protected by the Fairing.

For multiple launches the configuration can be :

- A main Spacecraft mounted on top of the adaptor and up to 3 micro-satellites mounted on a platform (like the **A**riane **S**tructure for **A**uxiliary **P**ayload - **ASAP** concept), fixed on the adaptor,

- A satellite cluster laid on a dispenser, mounted on top of the adaptor.

4.5.2. Spacecraft accessibility

Several access doors are provided :

- One access door, 420 mm diameter on the fairing cylindrical part on each half, for access to the payload,

- One access door, 300 mm diameter on the fairing low part, for access to connectors.

Any request for aperture outside the above limits will be subject to a special feasibility study.

4.5.3. Adaptor

The spacecraft is mounted on the top of the launch vehicle via an adaptor.
The standard interface plane between the launch vehicle and the spacecraft is a 937 mm diameter providing a clampband fixation device.

Figure 4.2 gives the definition of the Ø937 mm interface frame.

The mounting plane for the spacecraft is orthogonal to the Launch Vehicle longitudinal axis.

4.5.4. Usable volume

The envelope volume (static + dynamic) allocated to the spacecraft is shown on figure 4.3.

4.6. ELECTRICAL AND RADIO ELECTRICAL INTERFACE

4.6.1. Earth potential continuity

The spacecraft is required to have an "Earth" reference point close to the separation plane, on which a test socket can be mounted.
The resistance between any metallic element of the spacecraft and a closest reference point on the structure shall be less than 10 mΩ for a current of 10 mA.

Spacecraft structure in contact with the launch vehicle (separation plane of the spacecraft rear frame) shall not have any treatment or protective process applied which creates a resistance greater than 10 mΩ for a current of 10 mA between the spacecraft earth reference point and that of the launch vehicle.

4.6.2. Services available at the base of the spacecraft adaptor

The following standard services are available at the Ø937 mm interface :

On ground services : Interface with the S/C GSE via the umbilical link using TBD Connectors.

Standard services shall include:

- 8 dry loops;
- 6 separation status (available via Telemetry);
- 5 separation detection straps (aimed at satellite initiation);
- 10 analogic measurements (available via the LV Telemetry);
- 1 Ground/Payload connector (72 pins TBC – 1x36 + 3x12).

Optional services shall include as a minimum:

- 1 dedicated power supply;
- 4 electrical orders (derived from power supply outputs in conjunction with dedicated open loops);
- pyro commands (from the remained unused outputs for the LV needs).

4.6.3. Radio and electromagnetic constraints

4.6.3.1. Fairing Window transparency for spacecraft radio-communications

Available under request.

4.6.3.2. Operating constraints

The spacecraft shall not radiate a narrow-band electrical field at the level of **A**VUM **A**vionics **S**ection - **AAS** exceeding the limit set in Figure TBD.

A 20 dBμV/m level radiated by the spacecraft, in the launch vehicle telecommand receiver 400 – 500 MHz band, shall be considered as the worst case of the sum of spurious level over a 300 kHz bandwidth.

Spacecraft transmitters have to meet general IRIG specifications.

During all the Launch Vehicle phases, the Power of Spacecraft shall be off, if not differentially indicated.

4.6.3.3. Electrical and radio-requirements for the launch phase

- Electrical requirements : the User shall design the spacecraft so that, during the final preparation phase leading up to the launch, the umbilical cables are carrying only very low currents (less than 100 mA – 50 V for a resistive circuit) at the moment of lift-off.

Spacecraft power shall be switched from external to internal and ground power supply must be switched off before lift-off.

- Radio requirements : the spacecraft telemetry frequency band must not overlap the launch vehicle bands :

2203 MHz ± **250 MHz**
2218 MHz ± **250 MHz**
2227 MHz ± **250 MHz**

TBD

Figure 4.2 Diameter 937 mm Interface Frame

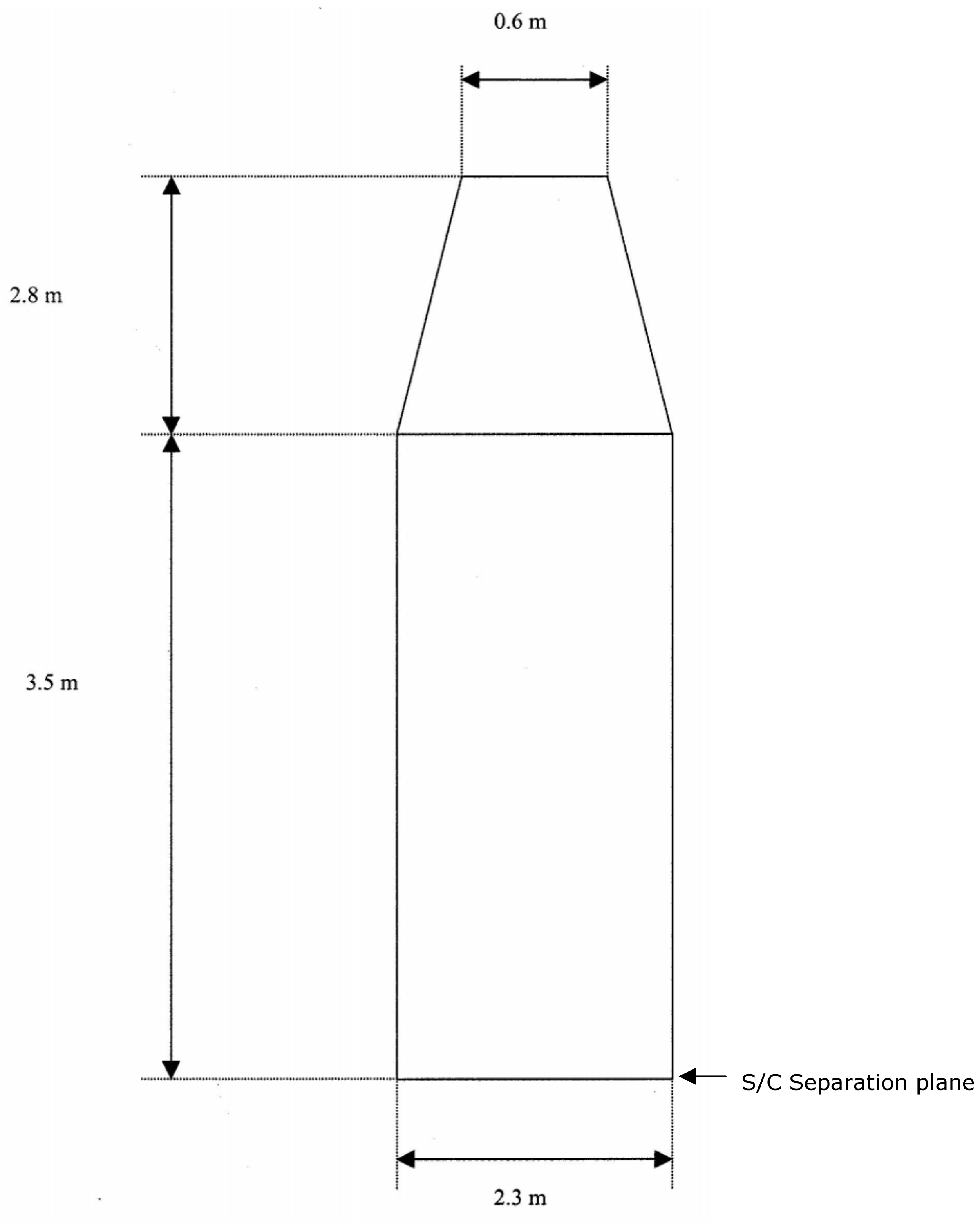


Figure 4.3: Payload dedicated envelope volume (static + dynamic)

Chapter 5
Launch Operations

Launch Operations Chapter 5

5 .1 GENERAL

VEGA launch operations are carried out from the European Spaceport in French Guiana the Guiana Space Centre – **C**entre **S**patial **G**uyanais (**CSG**).

The launch campaign and the flight will use the general facilities of the Spaceport already developed for ARIANE 4 & 5, the **EPCU** (**E**nsemble de **P**reparation des **C**harges **U**tiles, Payload Preparation Complex), the Ground Tracking Stations, will follow the Safety authorities requirements and will use the Logistics support.

The preparation launch campaign will also require specifics installations and supports equipment that have to be created.

This chapter describes the typical spacecraft operations in Guiana.

5.2. LAUNCH CAMPAIGN ORGANISATION

During the operations at the European Spaceport, the User interfaces with the Mission Director – **C**hef de **M**ission (**CM**) representing the entire Launch Authority (Arianespace, ELV S.p.A. and CSG).
The Program Director – **C**hef de **P**rogramme (**CP**), the User's contact in the previous phases, maintains his responsibility for all the non-operational activities.

The launch campaign organization is presented here below.

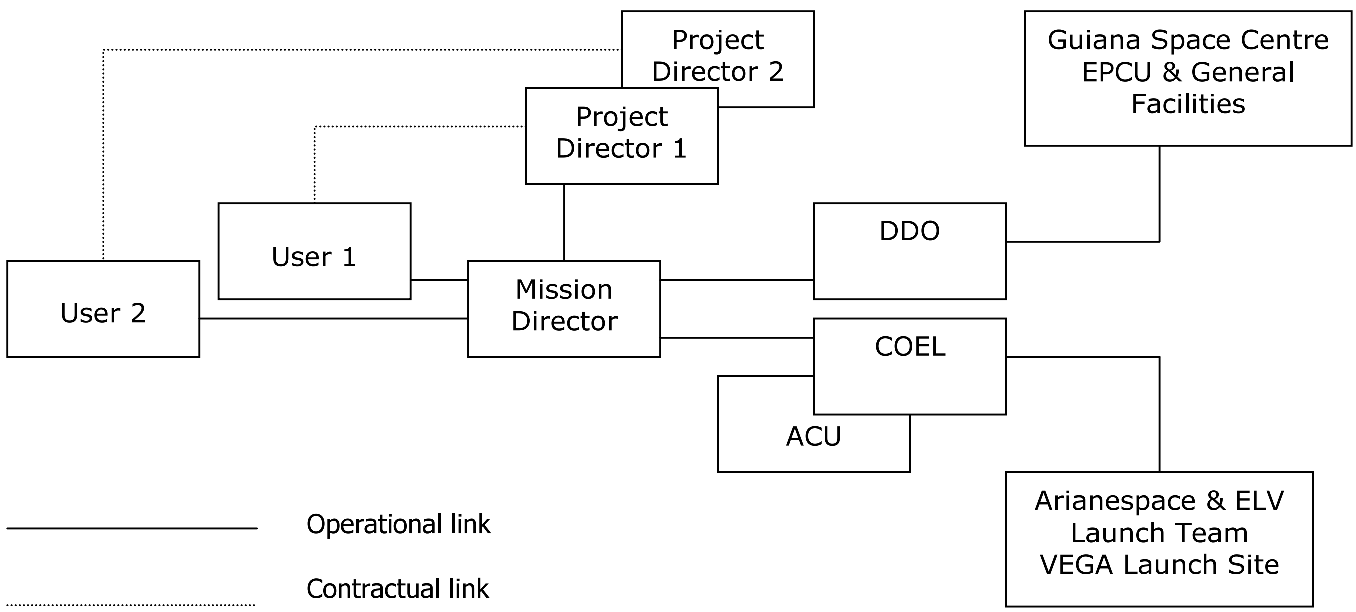


Fig. 5.2.a. – Launch campaign simplified organization chart

5.3. OPERATIONAL SAFETY CONSTRAINS

The Safety Regulations define the rules applicable to all operations involving the use of hazardous systems or products, and the constraints to be observed in the definition and performance of launch vehicle and spacecraft operations.

5.3.1. Limits of liability

The Spacecraft Authority is responsible for all spacecraft and associated ground equipment operations. When potential sources of danger are handled by CSG personnel, operations remain under the responsibility of the Spacecraft Authority.

Safety of the User's team comes under the general heading of safety of personnel working at the CSG, governed by CSG Safety Regulations.

Any activity involving a potential source of danger is to be reported to CSG, which in return takes all steps necessary to provide and operate adequate collective protection equipment, and to activate the emergency facilities.

Each member of the spacecraft team must comply with the safety rules regarding personal protection equipment. This is checked by CSG, which gives the relevant clearance to start operations.

On request from the User, CSG can provide specific items of protection for members of the spacecraft team. Upon arrival at CSG, spacecraft personnel will be given safety courses. In addition, training courses on the operations of range facilities will be given to appointed operators.

All payload activities on the launch site are carried out in accordance with instructions given in the related procedures prepared by the User and by the VEGA Authority where combined operations are concerned. These procedures are approved by the CSG Ground Safety Department, and covered by formal authorizations.

5.3.2. Constraints

5.3.2.1. Ground Constraints

The launch vehicle and the payload (composed of one or more spacecraft) represent hazards for one another.

Restrictions on payload operations and access may therefore be imposed during periods of combined operations due to safety constraints.

Coordination is exercised by the VEGA Authority.

5.3.2.2. Flight constraints

- During the powered phase of the launch vehicle and up to separation of the payload(s), no command signal can be sent to the payload(s), or generated by a spacecraft onboard system (sequencer, computer, etc...).
  During this powered phase a waiver can be studied to make use of commands defined in paragraph 4.6 proving that the radio electrical environment is not affected.

- After the powered phase and before the spacecraft separation, the commands defined in paragraph 4.6 can be provided to the spacecraft.

- To command operations on the payload after separation from the launch vehicle, microswitches or command systems (after 20 s) can be used. Initiation of operations on the payload after separation from the launch vehicle, by a payload on-board system programmed before lift-off, must be inhibited until physical separation.

Table 5.2 presents the Flight constraints.

H0 – 1h30 mn ⇩ **Upper Stage burn-out** ⇩ **Separation** ⇩ **Separation + 20 s** ⇩

Command	NO	NO	NO	YES
S/C Sequencer	NO	NO	YES	YES
L/V orders	NO (Waiver Possible)	YES	NO	NO

Table 5.2 Flight Constraints

5.4. SPACECRAFT FIELD OPERATIONS AND PLANNING

The basic assumption on spacecraft integration on VEGA, is that the S/C is prepared, integrated on the adaptor and encapsulated in the clean rooms of the EPCU, afterwards no intervention is normally scheduled on the Spacecraft.
Only monitoring, check of links and batteries charge are authorized.

Buildings and associated facilities available for spacecraft preparation are described in the EPCU Manual.

The VEGA operations can be divided in 6 main phases :

- **The pre-campaign** :
  - First stage integration in the **BIP** – Bâtiment d'Intégration des Propulseurs.

  This phase has to be completed before the campaign itself (which deals with the integration of other stages).

- **The launcher propulsion part campaign** in which :
  - Stage 2 is integrated on stage 1,
  - Stage 3 is integrated on stage 2,
  - AVUM is integrated on stage 3,
  - The corresponding functional links are installed to the ground

  The launcher at this state is checked (Synthesis Control), to be ready for the upper assembly integration.

- **The spacecraft preparation in EPCU**

  - S/C preparation and checkout inside non hazardous area (unpacking, preparation, functional check),
  - transfer from non hazardous area to hazardous area,
  - S/C hazardous operations inside hazardous area (filling, SPM and battery mounting, balancing , weighing and checking).

  Final allocation in the EPCU Buildings (non hazardous area and hazardous area) is given by the Mission Director by the time of the Final Mission Analysis Review – **R**evue d'**A**nalyse de **M**ission **F**inale (**RAMF**).

- **Upper Assembly constitution** (spacecraft + adaptor + fairing) in hazardous area :

  - Transfer from Airport (or Harbour) towards EPCU Buildings.
  - Adaptor unpacking and preparation,
  - Halves fairing unpacking and preparation,
  - Integration of S/C on the adaptor,
  - Integration of the two half fairing around the S/C,
  - Check of the Upper Assembly,
  - Preparation to transfer.

- **Combined operations** with launcher :

  - Transfer of the Upper Assembly on the AVUM,
  - Integration on AVUM,
  - Check of Upper Assembly link to the launcher and to the ground,
  - Filling of the AVUM,
  - Arming and inspections.

- **Final sequence** :

  - Removal of the Gantry,
  - Launch count-down,
  - Lift off.

The spacecraft is mainly involved in the following phases that will be described in more details :

- Spacecraft preparation and checkout in EPCU,
- Spacecraft hazardous operations in EPCU,
- Upper Assembly constitution in EPCU,
- Combined operations,
- Final sequence.

5.4.1. Phase 1: Spacecraft preparation and checkout in EPCU

Details of harbour and airport facilities are given in Annex 1 and also described in the EPCU CD-ROM.
Unloading is carried out by the harbour or airport authorities under the Users responsibility in coordination with Arianespace.
Equipment should be packed on pallets or in containers and protected against rain and condensation.

Harbour and airport are linked to the European spaceport by road. Transport within French Guiana is coordinated by the VEGA Authority and usually carried out by CSG.

On arrival at the CSG Technical Centre, the spacecraft in its container, together with associated ground equipment, are unloaded in the Preparation area Transit Hall.
However the spacecraft in its container could be directly transported to the Hazardous building.

In the Spacecraft Operations Plan – **P**lan d'**O**perations **S**atellite (**POS**), the User defines the way his equipment should be arranged and laid out in CSG buildings.

The VEGA Authority is in charge of equipment unloading and dispatching operations.
Solid motors (if any) in their containers are stored in SPM buildings of the ZSP.
Pyrotechnic systems and any other hazardous systems of the same class are stored in the pyrotechnic devices buildings of the ZSP. Hazardous fluids are stored in the propellant-support zone of the launch site.
Radioactive sources are normally stored in Preparation building unless otherwise specified by CSG Safety.

The User states which equipment has to be stored in an air-conditioned environment.
Other equipment will be stored under open shed conditions.

Spacecraft check-out equipment is accommodated in Preparation building and connected to the CSG power and operational networks with CSG support.

The spacecraft is removed from its container and deployed in the Preparation clean room.
This also applies for flight spare equipment.

The spacecraft is assembled and undergoes functional checks (non-hazardous mechanical and electrical tests). Category B pyrotechnic items only may be integrated into the spacecraft in Preparation building.

Appropriate operations interfacing with Launch Vehicle operations are carried out during this phase (such as: mechanical fit check, electrical check out of flight adaptor and ground lines, etc ...).

When all checks have been completed, the spacecraft is placed in its own container or in the Payload Container – **C**onteneur **C**harge **U**tile (**CCU**) for transport to the VEGA Launch Complex.

5.4.2. Phase 2: Spacecraft hazardous operations in EPCU.

Hazardous operations are carried out in S2 and S4 buildings for **S**olid **P**ropellant **M**otors (**SPM**) and Filling Hall for spacecraft. Liquid propellant motors are prepared in a filling hall in Filling Hall.

Validation of spacecraft ground equipment such as filling and pressurization systems are carried out by the Spacecraft Authority in Hazardous building before arrival of the spacecraft. The SPM is assembled to the spacecraft in the same hall of Hazardous building.

The spacecraft operations performed in Hazardous buildings will be monitored from a dedicated Control Room , CDL3 or directly from Preparation building. The associated **E**lectrical **G**round **S**upport **E**quipment (**EGSE**) used during hazardous operations may be located in and operated from the dedicated control room, CDL3 or directly operated from Preparation building.

Some phase 2 operations can be undertaken in parallel with phase 1 operations.

5.4.2.1. Pyrotechnic preparation

Checks of pyrotechnic systems required before integration into the spacecraft are carried out in S2 building.

5.4.2.2. Preparation of SPM

Removal from storage and transport to S2.

SPMs stored in the SPM building of the ZSP, can undergo X-ray examination in S4 building, before or after transport in their containers, to S2 building. SPM X-ray checks are carried out by the User with VEGA technical support.

Preparation and checks.

The SPM is assembled and checked. The pyrotechnic motor ignition system is transported from the pyrotechnic devices building of the ZSP to S2 building for check prior to assembly into the motor.

Packing and transport to Hazardous building*.*

When fitted with its igniter, the SPM is placed in its container and transported to the access airlock of Hazardous building.

Preparation for assembly.

The SPM, with its igniter fitted, is removed from its container, and placed in one of the Hazardous building Filling and Assembly Halls.

5.4.2.3. Operations on spacecraft

5.4.2.3.1. Transport and installation in Hazardous building

The spacecraft in its container or in a CCU (see EPCU manual) is transported from Preparation area building to the access air lock of Hazardous building no earlier than 20 working days before launch. It is then removed from the container, and placed in one of the filling and assembly halls. If Preparation area building is not used, the spacecraft in

its container is transported directly from airport or harbour to access dock of Hazardous building, not earlier than 20 working days before launch.

The pressure and temperature monitoring equipment are located in the S3C or Hazardous building laboratories.

The spacecraft **C**heck-**O**ut **T**erminal **E**quipment (**COTE**) - if any - is linked to the **O**verall **C**heck **O**ut **E**quipment (**OCOE**) by lines to allow remote control.
Depending upon COTE necessity to charge batteries one or two COTE has to be supplied by the customer. This analysis will be done on a case by case basis.

The COTE main functions will be:

- S/C ground power supply.
- Hazardous circuits activation (AKM...).
- S/C critical status recording during roll-out.

It will be connected directly to the Ground Umbilical lines of the launch Mast.

5.4.2.3.2. Fluid filling and pressurization

The spacecraft tanks are filled and pressurized to flight level.
When necessary, depressurization, purging and flushing operations may be carried out in a Hazardous building Filling Hall.

Propellant fluid filling and pressurization operations are carried out by the User. The pressure and temperature monitoring equipment is located in dedicated control room.

Spacecraft batteries may be charged in Hazardous building, except during dynamic hazardous operations.

Ground lines (continuity, insulation, etc ...) between Hazardous Buildings, hardlines and radio links between Hazardous and Preparation buildings have been checked previously and certified by Arianespace (and witnessed by the Spacecraft Authority if so requested).

5.4.2.3.3. Assembly of pyrotechnics, radioactive sources and miscellaneous items

The assembly of various hazardous items (category A pyrotechnic devices, SPM, radioactive sources, etc...) into spacecraft is carried out in Hazardous building.

ina s acecra t assemb y

5.4.2.4.1. Balancing and weighing

If required by the User, a balancing operation may be carried out on the spacecraft, with or without SPM and fluids, under the responsibility of the User, with CSG technical support. A weighing device is available in each Filling and Assembly Hall
(the balancing machine is located in S3A building).

5.4.2.4.2. Checks and inspection

Electrical, mechanical and arming checks are carried out in the Hazardous building assembly hall. A spacecraft final inspection is made before the beginning of the Combined Operations Plan – **P**lan d'**O**perations **C**ombinées (**POC**) (refer to chapter 6).

5.4.3. Phase 3: Upper Assembly constitution in EPCU

5.4.3.1. S/C and Adaptor assembly in Hazardous building.

The adaptor has been checked and is ready. It stays on the specific composite base which has been placed on a stand.

- Mechanical mating of the S/C on the Adaptor,
- Electrical connections and control.

5.4.3.2. Encapsulation

- Two halves fairing mechanical mating,
- Ventilation preparation installation,
- Electrical connections and control,
- Check of the S/C,
- Customer logo installation.

5.4.4. Combined operations

5.4.4.1. S/C transfer to Launch Pad

The electrical links to the launcher and to the ground has been checked before the start of the Combined Operations phase.

- In Hazardous building, transfer of Upper Assembly (fairing + S/C + Adaptor) from the stand to the trailer by the composite lifting device and the crane,
- Transfer from the trailer to the launcher by means of the composite lifting device and the crane.

5.4.4.2. Composite integration on launcher

The S/C is inside the volume composed of the fairing and the adaptor, there is no direct interface between the launcher or the ground, and the S/C.

- Mechanical mating of the adaptor on the AVUM,
- Connection to ground venting,
- Electrical connections and checking.

After this phase, the S/C is in a standby mode, under control from the CDL and stays with venting (batteries can be charged if needed).

No access to the Spacecraft is scheduled in the Tower.

5.4.5. Final sequence

The S/C is in a standby mode, under control from the CDL, and stays under ventilation until lift off.

5.5. ELECTRICAL OPERATIONS

5.5.1. Lower composite electrical operations

The electrical activities will be performed on the lower composite (stage 1+2+3+AVUM) after the mechanical assembly of all those stages and the completion of the electrical connection.

Functional tests are performed for each chain through the **O**n-**B**oard **C**omputer (**OBC**), activated by a specific control program.

For TVC, the functional control is performed via the Flight Computer. A sign check by direct observation of nozzle movement is performed (TBC).

Finally, a synthesis control is performed to check the overall system activity and the link to the CDL.

5.6. UPPER COMPOSITE INTEGRATION

5.6.1. Upper Composite Integration in EPCU

During Upper Assembly constitution in EPCU, each part has been electrically checked before integration by specific tools.

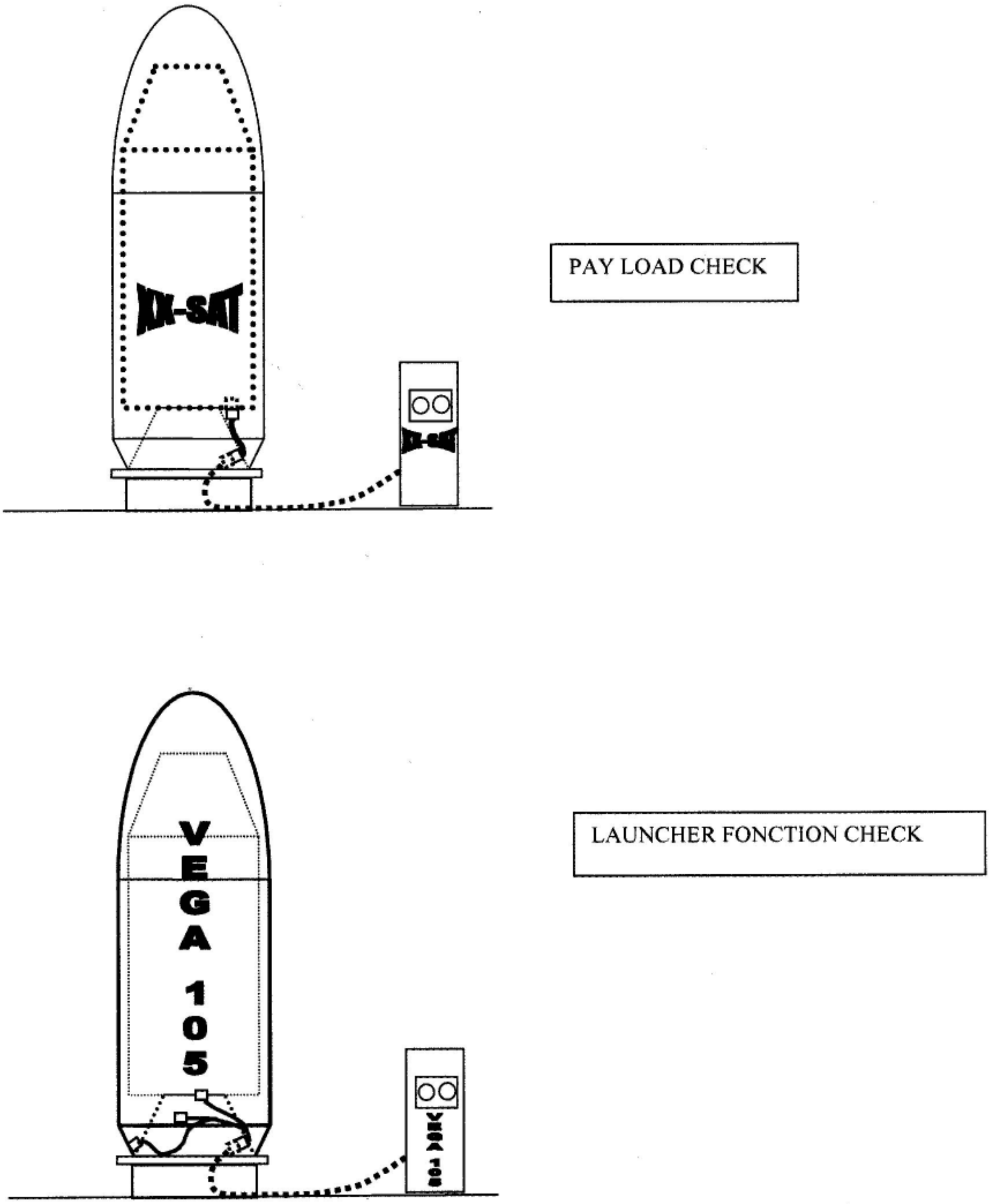
The whole Upper Assembly is checked before transfer to the LV assembly area:

- For the S/C by its own control bay, via tool connections at the adapter / AVUM interface,
- For the LV activities by a specific control bay inside the EPCU.

5.6.2. Upper Composite Integration on Launch Vehicle

Before the upper composite arrival on the LV, all the connections between AVUM / adapter interface and the LV have been checked, what means also the links to the POE dedicated to the S/C and the link between POE and S/C EGSE inside the CDL.

After mechanical integration and connection between AVUM and the Adapter, a final check will be performed by the LV to control the pyrotechnics orders, by means of test program from the CDL.



COMPOSITE AND LAUNCH VEHICLE FUNCTIONAL CHECKS

5.7. LAUNCH CONSTRAINTS

5.7.1. Mission Integrated Schedule

Typically, the mission analysis duration is of TBD months.

5.7.2. About Launch window

Some definitions about launch constraints :

5.7.2.1. Launch period

It is the period in which the launch is allowed with daily launch window possibilities.
The launch period is 3 calendar months (TBC).

5.7.2.2. Launch Slot

It is a given period inside the launch period.
The launch slot is 1 month within launch period (TBC).

5.7.2.3. Launch day

It is the day, within the launch slot, during which the launch window starts. It is fixed in agreement with the User. The latest acceptable launch day is scheduled 10 days (TBC) earlier than the end of the launch slot.

5.7.2.4. Launch time

It is launch lift-off time, defined in hours, minutes, seconds, within one launch window.

5.7.2.5. Satellite injection window

It is the daily limited window during which satellite injection into the required orbit is achievable.

5.7.2.6. Launch window

A launch window starts at the beginning of the satellite injection window advanced by the VEGA powered flight time.
The launch window last the same time than the satellite injection window.

The daily launch window will be at least (TBD) minutes long, in one or several parts.
Shorter daily duration may be negotiated

5.7.2.7. Launch capability

There are no operational limitations coming from the Launch Vehicle.
Some constraints may come from :

- The tracking stations availability,
- The Weather forecast.

For northern orbit missions, some more constraints may come from :

- Conflicts between the launch window and the LV performance capability
- Safety requirements

5.7.3. Launch postponement

If the launch does not take place during the launch window of the scheduled launch day , the launch will be postponed by 24 hours or 48 hours depending on the situation.

5.8. OPERATIONAL ORGANIZATION RESPONSIBILITIES

PDG Arianespace - Chief Executive Officer (Responsible of the Arianespace's commitments - Flight Director)

DG Arianespace – Chief Operating Officer

DMS Spacecraft Mission Director
(User) ("Directeur de la Mission Satellite"). Responsible for checking the Compatibility of his spacecraft mission objectives with the capability of the launch system. The CM may not proceed with the launch without the agreement of the DMS.

CPS Spacecraft Project Manager
(User) ("Chef de Projet Satellite"). The CPS delegates preparation, activation and checkout of the spacecraft to the Spacecraft Preparation Manager (RPS).

Note: *The DMS or CPS is responsible for synthesis of reports (spacecraft preparation and satellite orbital ground station network).*

RPS Spacecraft Preparation Manager
(User) ("Responsable de la Préparation Satellite"). Responsible for the preparation, activation and checkout of the spacecraft.

RCUV VEGA Payload Manager
(AE) ("Responsable Charge Utile VEGA"). Responsible for the compatibility between the launch objectives and the VEGA Launch system.

ARS Satellite Ground Stations Network
(User) Assistant ("Adjoint Reseau Stations sol satellite") Responsible for liaison between the CSG control room and the Satellite Orbital Operations Centre

CM Mission Director
(AE) ("Chef de Mission") Responsible for preparation and e Execution of the launch campaign.

CPVP VEGA Production Project Manager
(AE) ("Chef de Projet VEGA Production") Responsible of the VEGA Design Authority.

CG/D Range Director.
Delegates:
1) preparation, activation and operational coordination of the CSG facilities and the down-range stations to the Range Operations Manager (DDO).
2) safety of persons and property to the Safety Officer.

DDO Range Operations Manager
(CSG) ("Directeur d'Opération") Responsible for the preparation, activation and operational coordination of the Range facilities and the down-range stations.

RMCU Payload facilities Manager
(CSG) ("Responsable des moyens charge Utile") Responsible for EPCU maintenance and operation technical support.

RS Safety Responsible
(CSG) ("Responsable Sauvegarde") Responsible for the safety of persons and property.

COEL Launch Site Operations Manager
(AE) ("Chef des Opérations Ensemble de Lancement") Responsible for the preparation, activation and checkout of the launch vehicle and launch-complex facilities. Coordinates all operations on the launch pad (Tower and CDL)

ACU Payload Deputy
(AE) ("Adjoint charge utile"). COEL assistant for the Launch System/Payload combined operations coordination.

ISLA Launch Area Safety Officer
(CSG)("Ingénieur Sauvegarde Lancement"). Represents the Safety Officer on the launch site.

ISCU Payload Safety Officer
(CSG)("Ingénieur Sauvegarde Charge Utile"). Responsible for control of the payload hazardous operations.

A typical operational countdown organization is presented figure 5.5.a.

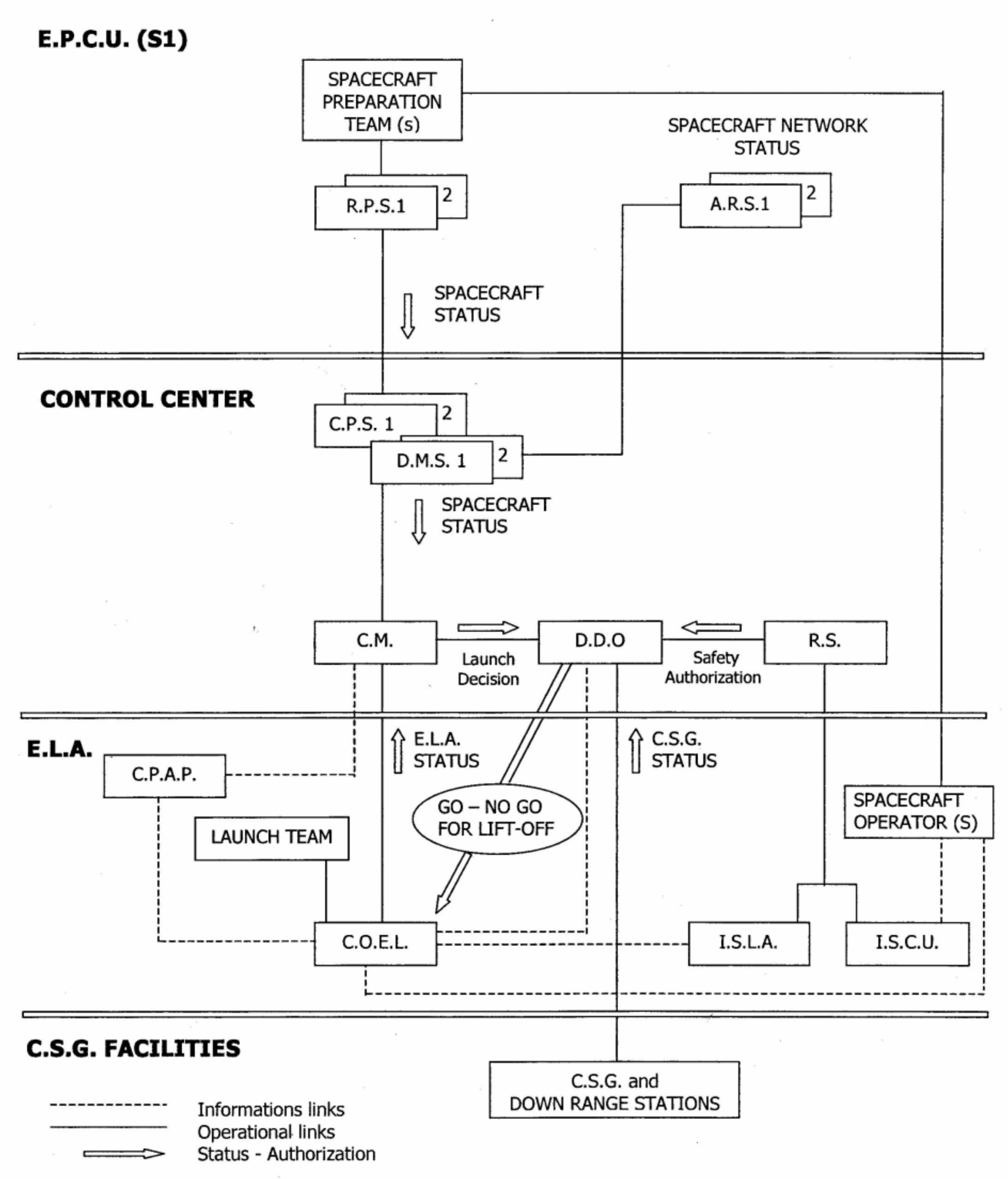


Figure 5.5.a – Typical Operational Countdown Organisation (As an example ARIANE Organization)

5.9. Orbital operations support network

The satellite orbital operations are not a VEGA responsibility.

5.10. Evaluation of the parameters at injection

Between H0 + 40 minutes and H0 + 1 hour the VEGA Authority will provide the User with the composite satellization diagnosis. This information includes an estimate of orbital parameters at injection and fourth stage attitude just before the Spacecraft separation from the Launch Vehicle.

Chapter 6
Documentation

Documentation Chapter 6

This chapter describes the documentation which will become applicable when the VEGA launch system is adopted by a User.

6.1. VEGA MISSION INTEGRATION SCHEDULE

The documentation system and activities associated with an VEGA mission typically cover a 24 months period as shown in figure 6.1.a. This schedule may be modified to suit the User's requirements.
The activities shown in figure 6.1.a. are typical for a first-time VEGA mission; repeat missions of an identical nature may only require the reviews and an update of the analyses and associated documents.

6.2. INTERFACE MANAGEMENT

Interface Management is based on the **I**nterface **C**ontrol **D**ocument (**DCI**) which is issued by Arianespace using inputs extracted from the technical annexes of the Launch Services Contract and from the "**A**pplication to **U**se **V**EGA" (**DUV**) provided by the User.

6.2.1. Application to use VEGA

("**D**emande d'**U**tilisation **V**EGA" - **DUV**) Refer to annex 3.
The User is required to issue a DUV in which the spacecraft interfaces with the launch system are defined i.e.:
a) Mission characteristics (orbit, orientation at separation, operations after separation,…),
b) Spacecraft data (mass, alignment, inertias, geometrical data, electrical and radio electrical interfaces, hazardous systems,...).
c) Launch preparation at CSG (use of EPCU buildings including storage areas, communications networks requirements, spacecraft prelaunch operations on the launch site and countdown operations).
d) Spacecraft development and test plan.
DUV detailed contents list can be provided to the User on request.

6.2.2. Interface Control Document

("Dossier de Contrôle d'Interface" - DCI) Arianespace prepares the DCI in response to the DUV and the technical annexes of the Launch Services Contract. The DCI collates all interface requirements common to the launch system and the spacecraft, and illustrates their respective compatibility.
The DCI is approved by both Arianespace and the User and is maintained under formal configuration control until the launch.
After approval, the DCI becomes the basic and sole working document with respect to technical aspects and identification of the operational activities.

6.3. SAFETY BASELINE DOCUMENTS

6.3.1. General

CSG is responsible for drawing up Safety Regulations, and ensuring that they are observed.
All launches from the CSG require approvals from Ground and Flight Safety Departments; these approvals cover launch vehicle-payload hazardous systems and the flight plan respectively. In order to obtain this approval, a User has to demonstrate that his equipment and its utilization comply with the provisions of the Safety Regulations.

TBD

Fig. 6.1.a – Typical time schedule of documentation and reviews

This demonstration is achieved in a number of stages, by the submission of documents defining and describing the hazardous elements and their operation. Submission documents are prepared by the User and forwarded to the VEGA Authority.

6.3.2. Submission procedure

This procedure, defined in C.S.G. Safety Regulations RS, CSG Vol.2 - Fasc. 3 and summarized hereafter, aims at a mutual understanding of problems, and their solutions, from the start of the project onwards in order to avoid loss of time and money resulting from the need for late modifications to the design or manufacture of systems classified as hazardous by CSG.
Documents related to a given project are submitted in three phases:

Phase 1 Submission:

The User prepares a file containing all the documents necessary to inform CSG of his plans with respect to hazardous systems.
This file contains a description of the hazardous systems. It responds to all questions on the hazardous items check list given here after.
A safety check list is given in the CSG Safety Regulations to help for the establishment of the submission documents, its deals with the following topics:

1. ELECTRO-EXPLOSIVE DEVICES
1.1. Description
1.2. Location, function, date and place where fitted to spacecraft
1.3. Safety

2. SOLID PROPELLANT MOTORS
2.1. International classification
2.2. Manufacturer and references
2.3. Has it been used previously ?
2.4. Description
2.5. Ignition system
2.6. Firing and monitoring circuit
2.7. Storage and transfer containers
2.8. Associated ground support equipment

3. LIQUID PROPELLANT MOTORS
3.1. Nature and quantity of propellants
3 2. Propulsion system - Waivers
3 3. Associated ground support equipment

4. ATTITUDE CONTROL (see § 3)

5. PRESSURE LEVELS
5.1. Nature of fluids
5.2. Tanks
5.3. Associated ground support equipment

6. GROUND SUPPORT EQUIPMENT

7. BATTERIES
7.1. Type, description
7.2. Pressurization (§ 5)
7.3. Hazardous fluids
7.4. Charge

8. RADIATIONS
8.1. Non-ionising radiations
8.2. Ionising radiations

9. INTERFACES
9.1. Mechanical interfaces
9.2. Electrical interfaces

10. MISCELLANEOUS

- Other safety problems not so far dealt with

The document shall cover all safety related activities: component choice, safety and warning devices, fault trees for catastrophic events, and in general all data enabling risk level to be evaluated.

CSG will study this submission, classify the hazardous systems described, and declare any special requirements imposed by its Safety Departments.

Phase 2 Submission:

The User submits the hazardous systems manufacturing, qualification and acceptance documentation as soon as it becomes available. This must satisfy the requirements laid down by CSG at the end of Phase 1. This documentation gives the requirements for providing EPCU equipment or facilities to be used during the launch campaign, and all other documents required by CSG during phase 1 and 2 submissions. It also defines the policy for checking and operating all systems classified as hazardous.

CSG checks that the documentation delivered in phase 2 complies with the requirements specified in Phase 1, states its intentions concerning verification of systems classified as hazardous, and defines the draft procedure to be applied during spacecraft activities in French Guiana.

Phase 3 Submission:

The User submits a verification and operating procedures for systems classified as hazardous, with detailed description of verification policy and its execution.
After implementation of all changes that are considered necessary, CSG accepts the procedure.
This becomes the sole authorized document to be applied by the User during the launch campaign, under the supervision of CSG Ground Safety Department.

6.3.3. Time schedule for safety activities

In the general interest, that the User completes the safety questionnaire well ahead of the formal submission phases, so that the earliest possible allowance can be made in designing the spacecraft on-board and ground equipment.

The following time-schedule for formal submissions shows the requested deadlines working backwards from the launch date L.

SAFETY SUBMISSIONS TIME SCHEDULE		
Typical schedule	Safety Submissions	Spacecraft Milestone
Earlier than L-24 months	Phase 0 preliminary submission	Contract
L-24 months	Phase 1 submission	
L-21 months (or 3 months after submission phase 1)	Response to phase 1 submission with classification of hazardous systems	PDR
As soon as available	Phase 2 submission (definition documents for systems classified as hazardous)	
3 months later	Response to phase 2 submission	CDR
L-8 months	Phase 3 submission (hazardous procedures)	
L-3 months	CSG approval of hazardous procedures	RAVS

Note: For an already developed spacecraft, phase 1 and phase 2 submissions are initiated as soon as the documentation is supplied by the User. The Safety Departments response is then provided within 3 to 4 months in order to be available for the spacecraft CDR. Such a short safety procedure allows the launch of a qualified spacecraft to be considered only 12 months after the VEGA launch system has been selected by the User.

Safety meetings between CSG safety departments and the User are recommended before CSG's response to submission phases.

6.4. Mission analysis

6.4.1. Introduction

A Mission Analysis is conducted to ensure that the mission objective can be achieved (reliable spacecraft injection into the required orbit and in the correct attitude).
The studies relate to flight plan and environment and are organized in two stages:

- A Preliminary Mission Analysis mainly concerned with the compatibility of the spacecraft design with the Ariane environment (see para. 6.4.2).
- A Final Mission Analysis mainly concerned with the actual flight plan and the final flight predictions covering, when applicable, the dual launch configuration (see para 6.4.3).
-

At the completion of each step, a **M**ission **A**nalysis **R**eview (**RAM** "**R**evue d'**A**nalyse de **M**ission") is held based upon the issued **M**ission **A**nalysis **D**ocumentation (**DAM** "**D**ossier d'**A**nalyse de **M**ission").

6.4.2. Preliminary Mission Analysis

Arianespace performs a Preliminary Mission Analysis which includes the following studies:

- preliminary trajectory and mission sequence,
- preliminary flight mechanics study,
- preliminary dynamic coupled loads analysis,
- preliminary radio frequency compatibility study.

a) In the case of a non-standard GTO mission the preliminary trajectory study enables the feasibility of the required orbit and the associated performance margin to be established. The resulting trajectory is then used as input data for various analysis such as orbit dispersion, loads, thermal, separation sequence and safety.
For a standard GTO mission, the standard trajectory document is issued to the User.

b) The preliminary flight mechanics study allows Arianespace to:

- verify the feasibility of the required orientation,
- define the necessary separation energy,
- verify the clearance at separation,
- determine the kinematic conditions after separation,
- issue a preliminary sequence of events,
- verify the orbital long-term clearance; in the event that a problem area is identified, corrective action will be recommended to the User.

c) The preliminary dynamic coupled load analysis allows Arianespace to produce the first prediction of the in-flight loads applicable to the User's spacecraft Using a preliminary spacecraft dynamic model provided by the User and conforming to the VEGA specification this study:

- performs the modal analysis for the composite launch vehicle and its payload,
- describes the dynamic responses of the spacecraft for the most severe l longitudinal and lateral load cases induced by the launch vehicle,
- gives, at the nodes selected by the User, min-max tables and time histories for forces, accelerations and relative deflections, as well as VEGA/Spacecraft interface acceleration and force time histories,
- allows the User to verify the validity of spacecraft dimensioning and to adjust its qualification test plan if necessary, after discussion with the VEGA Authority.

d) The preliminary radio frequency compatibility study allows Arianespace to check the compatibility between frequencies (and their harmonics) used by the launch vehicle, the ground stations and the spacecraft during launch operations (including flight). This study is based upon a spacecraft frequency plan (including intermediate frequencies) that the User has to provide within the DUA. The housekeeping telemetry and command of the spacecraft may be subject to change on request of ARIANESPACE up to 20 months before launch.

6.4.3. Final Mission Analysis

Arianespace performs the Final Mission Analysis covering the following studies:
- Final trajectory and mission sequence,
- Final flight mechanics analysis,
- Final dynamic loads analysis,
- Thermal environment,
- Final radio frequency compatibility,
- and, when applicable, dual launch compatibility.

a) The final trajectory study defines:
- The actual launch vehicle data to be used (mass breakdown, propulsion parameters adjustments), the actual launch vehicle payload data and the associated launch vehicle performance,
- The flight event sequence for the on-board computer,
- The guidance parameters for the on-board computer,
- The position, velocity and attitude of the vehicle during the boosted phase.

b) The final flight mechanics study repeats the studies performed during the preliminary analysis but takes into account the actual VEGA payload parameters and so enables Arianespace to:
- define the data to be used by the on-board computer for the orbital phase (manoeuvres, sequence),
- predict the clearance between the separated elements in orbital flight.

c) The final coupled loads analysis enables Arianespace to define the final prediction for in flight loads. Using a test-validated model provided by the User conforming to the VEGA specification, this study allows Arianespace:
- to verify, or adjust if necessary, the Spacecraft Acceptance Test Plan, and associated notching procedure when applicable,
- to verify that the Ariane payload does not affect the behaviour of the launch vehicle or its stability.

d) The thermal environment study is required to predict the temperatures during count down and flight. Using a thermal model provided by the User conforming to the VEGA specification, this study covers the period from spacecraft on VEGA in the launch tower up-to the injection into the desired orbit.

The study allows Arianespace to adjust the ventilation parameters during count down (tower removed, if any) in order to satisfy, in so far as the system allows it, the temperature limitations specified for the spacecraft.

e) The final radio frequency compatibility study considers the actual launch configuration. The study involves the examination of possible spurious emission frequencies and the susceptible frequencies of the receivers; in case of conflict the study will extend to the analysis of possible solutions either on the launch vehicle or on the payload.

f) The dual launch compatiblity study analyses the results of all mission analysis studies to ensure compatibility between spacecraft to be launched as a combined VEGA payload.

The aspects covered in the particular studies mentioned earlier are reviewed during the course of this study and are analysed with the focus on possible interference between spacecraft.

A simulation is performed of the motion of the elements after separation and up to apogee motor firing (if any), including spacecraft manoeuvres, in order to check long term collision avoidance, thermal flux and contamination aspects (due to AKM firings).

6.4.4. Spacecraft environment test file

The User is required to provide the VEGA authority with the spacecraft environment test Plan.
This plan is analysed at the time of the final Mission Analysis Review.

The User will then submit analysis and synthesis files resulting from the tests. These files are analysed at the Spacecraft Flight Readiness Review ("Revue d'Aptitude au Vol Satellite").

6.4.5. Payload mass characteristics

The mass of the payload in its final launch configuration must be notified to the VEGA authority prior to the Launch Readiness Review (RAL).

6.4.6. Post-launch documents

6.4.6.1. Inspection data

Arianespace will give first diagnosis and information sheets to the User before H0 + 60 min., concerning the orbit characteristics at injection (4th stage cut-off) and attitude of the spacecraft just before the spacecraft separation.

6.4.6.2. Orbital tracking operation report

Arianespace requires the User to provide orbital tracking data on the initial spacecraft orbits including attitude just after separation, for back-up evaluation of launch vehicle performance.

6.4.6.3. Launch evaluation report.

Arianespace draws up a report on the launch operations, based on processed launch vehicle telemetry and tracking data, showing the performance achieved and reporting on the behaviour of the launch vehicle and its subsystems.
A section of this report covering all launch vehicle/payload interface aspects is distributed to the User.

6.5. Launch preparation and range operations

The documentation necessary for launch operations is generated from the **L**aunch **R**equirements **D**ocument (**DL = D**emande de **L**ancement). As far as the spacecraft is concerned, the following data are used as input for writing the DL:

- the approved DCI, taken as a specification,
- the **S**pacecraft **O**perations **P**lan (**POS**) provided by the User,
- the **I**nterleaved **O**peration **P**lan (**POI**),
- and the master-schedule of the **C**ombined **O**peration **P**lan (**POC**) issued by Arianespace and taking account of both the POS and the Launch Vehicle Operation plan.

The POI and the POC master schedules are submitted to the User for approval.
The VEGA Payload Sections of the DL are submitted to the User for comment.

In parallel with this activity, procedures are issued, and phase 3 safety formalities are completed in order to have all the necessary documentation prepared and approved in time for the **F**light **R**eadiness **R**eview (**RAV** = **R**evue d'**A**ptitude au **V**ol).

6.5.1. Spacecraft Operations Plan.
(**P**lan des **O**perations **S**atellite – **POS**)

The User has to prepare a Spacecraft Operations Plan for the CSG, defining the operations to be executed on the spacecraft from arrival in French Guiana:
including transport, integration and checkout before assembly, and operations on the VEGA launch site. The POS defines the arrangements for these operations, and describes the facilities required for their execution.

A typical format for this document is shown here below.

1. GENERAL
1 1. Introduction
1 2. Applicable documents

2. MANAGEMENT
2.1. Time-schedule
2.2. Table of weekly activities
2.3. Meetings - Organization - Interface.

3. PERSONNEL
3 1. Organizational chart for spacecraft operations team
3 2. Definition of responsibilities and tasks
3 3. Spacecraft organizational chart for countdown

4. OPERATIONS
4 1. Handling and transport requirements for spacecraft and ancillary equipment
4 2. Tasks for launch operations

5. EQUIPMENT ASSOCIATED WITH THE SPACECRAFT
5.1. Brief description of equipment for launch operations
5.2. Description of hazardous equipment (with diagrams)
5.3. Description of special equipment (Launch Centre, Launch Mast or Tower)

6. INSTALLATIONS
6.1. Surface areas
6.2. Buildings (technical and logistic aspects)
6.3. Communications
6.4. Location of offices, assignment of personnel

7. LOGISTICS
7.1. Accomodation
7.2. Transport facilities
7.3. Packing list

6.5.2. Interleaved Operation Plan
(**P**lan des **O**pérations **I**mbriquées - **POI**)

Prepared by the DDO, the POI presents the spacecraft operations range support schedule from the time of arrival of the spacecraft equipment in French Guiana until the POC is started. The POI is submitted to the User(s) for approval.

6.5.3. Combined Operations Plan
(**P**lan des **O**pérations **C**ombinées – **POC**)

The POC identifies all activities involving a spacecraft and a part of the launch vehicle (operations in EPCU hazardous building when the spacecraft is encapsulated and on the Launch Pad).
Prepared by the COEL from the POS(s) and the Launch Vehicle Operation Plan, insofar as the launch vehicle payload is concerned, this document details the technical characteristics of the launch operations based upon the requirements imposed by both the payload and the launch vehicle.

The POC Master Schedule presents all spacecraft/VEGA activities from the time of spacecraft mating onto the VEGA adaptor until launch. All spacecraft operations during the countdown phase (RF tests, arming sequences, on board power supply switching,...) are included.
The POC Schedule is submitted to the User(s) for approval at the beginning of the campaign.

6.5.4. Launch Requirements Document.
(**D**emande de **L**ancement - **DL**)

The Launch Requirements Document prepared by the Arianespace Mission Director (CM) together with the Range Operations Manager (DDO) is a synthesis of both launch vehicle and payload aspects in terms of launch campaign preparation.

It defines the mission objectives, launch characteristics, general organization, time schedule and assistance required in terms of personnel, facilities, supply of fluids and support equipment.
It is adressed to CSG, and Arianespace/Kourou and to the customer for information.

The inputs for the DL regarding spacecraft related requirements are defined in the DCI the POS, the POI and the POC master-schedules.

6.5.5. Spacecraft operation procedures for the CSG

These procedures are prepared by the User for each operation defined in the Spacecraft Operations Plan (POS). All procedures covering the operation of systems classified as hazardous or those concerning personnel safety have to be submitted to the CSG Safety Departments for approval (see phase 3 submission).

6.5.6. Combined launch vehicle/payload operation procedures

Two types of combined operation are identified:
those requiring procedures specific to each Authority, and those requiring common procedures. Common procedures are prepared by the VEGA Authority, and submitted to the Payload Authority(ies) for approval.

6.6. Launch vehicle/payload reviews

Reviews are held, in accordance with figure 6.1.a, to conclude mission analyses phases, and to authorize blocks of work in the progress of the launch operations.

6.6.1. Mission Analysis Reviews

These reviews are conducted by Arianespace

a) The Preliminary Mission Analysis Review (**R**evue d'**A**nalyse de **M**ission **P**réliminaire - **RAMP**) is based upon the **P**reliminary **M**ission **A**nalysis **D**ocumentation (**DAMP**) comprising all reports issued during the Preliminary Mission Analysis (see para. 6 4.2).

The Spacecraft Authority attends the RAMP.
Conclusions from the RAMP lead to the updating of the DCI, and agreement on the spacecraft environmental test plan.

b) The Final Mission Analysis Review (**R**evue d'**A**nalyse de **M**ission **F**inale - **RAMF**)

In addition to aspects specific to the launch vehicle, the objectives of this review are to check the compatibility of spacecraft qualification status with the mission analysis results, to agree on applicable acceptance test procedures and to confirm the main mission parameters.

This review is held in relation to the Final Mission Analysis Documentation (DAMF) and when applicable, the dual launch compatibility analysis. In the latter case, the review is conducted in two stages, the second one involving both Spacecraft Authorities.
The conclusions of the RAMF lead to the updating of the DCI(s) and the release of data for the launch vehicle flight programme.

6.6.2. Launch-vehicle Flight Readiness Review
(**R**evue d'**A**ptitude au **V**ol du **L**anceur - **RAVL**)

The purpose of this review is to verify that the launch vehicle, following acceptance tests in Europe, is technically capable of executing its mission. One activity covered by the RAV concerns the examination of launch-vehicle/payload interfaces, with particular reference to the DCI, and the status of the launch preparation documentation (see para. 6.5).
The review is conducted by the Ariane Authority, and shipment of the launch vehicle to the CSG is contingent on a satisfactory conclusion.
The User is invited to attend the RAV.

6.6.3. Spacecraft Flight Readiness Review
(**R**evue d'**A**ptitude au **V**ol du **S**atellite - **RAVS**)

Arianespace requires to be represented at this review, normally held by the User before shipment of the satellite to the CSG. In particular, the VEGA Authority uses this opportunity to obtain the results of environmental acceptance tests, and the actual inertial and mass characteristics of the spacecraft.

6.6.4. EPCU Configuration Acceptance Review

The purpose of this review, held just before the arrival of the spacecraft and associated equipment at the CSG, is to verify that the buildings are configured according to the requirements contained in the Launch Requirements Document.
The configuration status is documented through a compliance certificate issued by CSG and approved by its Quality Control Department.

6.6.5. Combined Operation Release

A technical assessment of the related launch vehicle and spacecraft hardware is held to clear implementation of the POC. This meeting involves the safety department, the User and the COEL for the launch vehicle, with the CM as chairman.

6.6.6. Range Readiness Review

This review is held before the Launch Readiness Review (see para 6.6.7). Its purpose is to check the validation of the range, down-range stations and associated networks. The, review is chaired by the CSG in presence of the CM who approves the configuration on behalf of the Chief Operating Officer of Arianespace.

6.6.7. Launch Readiness Review
(**R**evue d'**A**ptitude au **L**ancement – **RAL**)

This review, conducted by the VEGA Authority, is held at CSG in order to review the overall status of all checks carried out on launch vehicle, payload and launch facilities and to authorize the final operations leading up to launch. The RAL normally takes place just after the launch rehearsal.
A dedicated payload session is requested by the CM to prepare for the main meeting.

Annex 1
European Spaceport and Arianespace in French Guiana

European Spaceport and Arianespace in French Guiana — Annex 1

1. French Guiana

1.1. Geography (see figs. A2.1 and A2.2)

French Guiana is a French Overseas Department (D.O.M.). It lies on the Altantic coast of the Northern part of South America. It is an equatorial region covering about 92 000 squares kilometers between latitudes 2° and 6° North at longitude 50° West.

It is bounded:

a) to the North, by the flat and marshy Atlantic coast covered with a recent alluvial layer,
b) to the West, by the Maroni river, which forms the natural frontier with Surinam,
c) to the East, by the Oyapock river separating Guiana from Brazil,

d) to the South, by the frontier with Brazil, which is formed by the watershed of the Amazon basin.

Most of the territory is covered with equatorial forest, only a coastal strip 1 to 30 km wide being habitable.

1.2. Climate

The climate is equatorial type, is fairly moderate for this latitude, with a temperature generally within a 25° - 30°C range, a low daily variation (5 to 10°C per day) and extreme temperatures of 18° and 34°C.

Despite relatively high rainfall (annual mean 3 m), there are two dry seasons: a short one in February/March with north-easterly trade winds, and the main dry season between July and early December, with easterly trade winds during the day.

The relative humidity is very high with a daily mean value varying between 60 % and 95 % corresponding to 15 to 22 g of water per cubic metre of air.

French Guiana lies outside the hurricane zone, and has light prevailing winds, mainly north-easterly. Despite its geographical situation, the coastal zone has a pleasant climate, breezy and sunny most of the year round.

1.3. Towns and population

The current population of French Guiana is more than 140 000.
The main towns are Cayenne, Kourou and Saint-Laurent du Maroni.

TBD

Fig.A2-1 – French Guiana and South America

TBD

Fig.A2-2 – French Guiana

1.3. Infrastructure and communications

- Sea links

The port of Cayenne is located in the south of the Cayenne peninsula in Degrad des Cannes. The facilities handle large vessels with 6 meters draught. The port is linked to Kourou by road.
The harbour facilities allow the container transfer in **Ro**ll-On/**Ro**ll-Off (**Ro-Ro**) or in **Lo**ad-On/**Lo**ad-Off (**Lo-Lo**).

The Pariacabo area is located near Kourou. This facility is more dedicated to the transfer of the launcher stages.

- Air links

Rochambeau international airport at Cayenne has a 3200 meters runway on which Jumbo-jets can land.
There are direct flights every day from and to Paris and via the West Indies.
Regular daily flights with North America are available via Guadeloupe or Martinique.

- Road links

The North-westward national road (RN1) links the mains towns of Guyana (Cayenne – Kourou - Sinnamary - Saint-Laurent du Maroni).
The South-eastward national road (RN2) links Cayenne, Rochambeau, Roura, Cacao, Regina.

- Telecom

All towns and facilities in Guiana are linked by telephone, telecopy to the international network.

1.5. Health

Yellow fever vaccination is mandatory for any stay in French Guiana.
Malaria is practically absent of the Kourou - Cayenne coastal strip.
Anti-malaria precautions are recommended for persons entering forest areas along river.
Hospital facilities with very complete and up to date equipment are available in Kourou and Cayenne.

1.6. Kourou

The town of Kourou lies on the coast, approximately 65 km north west from Cayenne.
The current population is about 14 000 inhabitants.
The town has:
- church and Oecumenical Centre,
- other facilities such as swimming pools, a stadium and a sports ground,
- three high-class hotels complexes with a total of more than 500 rooms and several kinds of restaurant with, with international cuisine. Various local and French cuisine restaurants are available downtown.

Kourou town is supplied with electricity main power voltage is 220 - 380 V at 50 Hz.
The town is supplied with drinking water by a pumping station 32 km upstream from the estuary of the Kourou river.
Kourou has all the essential amenities of a modern town such as shops, supermarket, restaurants, and craft trades.

2. The European Spaceport

French Guiana's location, close to the Equator, in an area outside the hurricane zone with the possibilities of launches in Northern to Eastern directions over the ocean, and regular air and sea connections were factors which led to the choice of Kourou forty years ago as the site for launching all types of european rockets including from the 70's the Ariane launch complex and from the near future the VEGA launch facilities.

2.1. General description

The **G**uiana **S**pace **C**entre (**CSG** – **C**entre **S**patial **G**uyanais), now the European spaceport operational since 1968 is managed on behalf the European Space Agency (ESA) by the Centre National d'Etudes Spatiales (CNES).
An agreement between the French government and ESA defines the rights and obligations of each party with regard to ESA's Ariane and VEGA launch sites and associated facilities.

Within the European spaceport perimeter, the following ESA facilities are namely operated:

- Ariane launch complexes ("**E**nsembles de **L**ancement **A**riane" - **ELA** 2 and 3), including facilities required for storage, final assembly, checkout and launch of Ariane Launch vehicles.
- VEGA launch complex ("**S**ite de **L**ancement **V**EGA" - **SLV**), including facilities required for storage, final assembly, checkout and launch of VEGA Launch vehicle.
- Liquid nitrogen, liquid oxygen, liquid hydrogen and solid propellant plants.
- Payload preparation complex ("Ensemble de Préparation Charge-Utile" EPCU), with facilities made available to Users for the preparation of their spacecraft.
- Agreements between ESA, CNES and ARIANESPACE define the conditions for utilisation by ARIANESPACE of ELA2, ELA3, SLV and EPCU.

2.2. Role of CNES/CSG

CNES/CSG's role is:

- To provide technical and logistic supports to the Ariane and VEGA launches such as telecommunication, meteo, plotting, telemetry and tracking to Arianespace and its customers in view to perform the L/V and S/C preparation campaign and the launch.
- To ensure in flight safety and on the range persons and assist safety and protection.

These activities comprise:

- Operation of range and of the down range, stations network.
- Data acquisition and processing from launch vehicles during flight, in real time and post flight.
- General coordination on the range and of the down range stations during ground spacecraft and launcher operations and launch countdown.

2. The Arianespace Establishment in Kourou

The Arianespace Establishment in Kourou was created in January 1982. It is a technical centre in charge of:

- Operations and maintenance of the Ariane and VEGA launch complexes.
- Support for launch campaigns of Ariane and VEGA launch vehicles.

Its activities are carried out in close cooperation with CNES/CSG as a subcontractor.

It should be noted that management of the Arianespace Kourou Establishment is independent from CNES/CSG range management and report to Arianespace Operation Directorate in EVRY.

Annex 2
Items ans services for a VEGA launch

Items and Services For a VEGA launch Annex 2

Within the framework of the launch contract ARIANESPACE supplies standard items and conduct standard services.
In addition, Arianespace proposes a tailored service: the General Range Support (G.R.S.) to suit the needs of satellite operations in French Guiana.
Optional items and services to cover specific customer's requirements are available on request.

These services are listed in the Technical Annexes of the Arianespace contract, they cover typically:

1. Hardware Supply and Services

ARIANESPACE shall supply the Hardware and Software to carry out the Mission, and provide services to the CUSTOMER as listed hereunder.

1.1. Launch Service Management

General Contract Management:
Contract amendments, payments, planning, configuration control, documentation, reviews, meetings, etc …

Launch Vehicle Production:
Testing, acceptance, and quality aspects, etc …

Mission Analyses
Launch Base Operations
Ground and Flight Safety:
Interface with CSG for Safety Submissions.

1.2. Hardware Supply

Launch Vehicle Hardware:

Launch Vehicle Propellants
One Flight Program
Spacecraft Adaptor:
Including the corresponding separation system.

Umbilical Interface Connectors

Fairing or Dual Launch Support Structure

Two Standard Access Doors:
At authorised locations, for access to the encapsulated Spacecraft.

Two Check-Out Terminal Equipment [COTE] Racks: TBD
Compatible with the Vega launch pad.

One Mission Logo:
Design to be supplied at L-6 by CUSTOMER.

1.3. Mission Analysis

Trajectory Study
Separation Analysis (Clearance, Kinematics, Collision)
Orbit Characteristics & Dispersion
Dynamic Coupled Load Analysis
Thermal Analysis
Radiofrequency Compatibility Analyses

Support for S/C Design Reviews
S/C Orbit & attitude data from L/V telemetry
(immediately before S/C separation)
Launch Evaluation Report [DEL]

1.4 Operations

Launch Vehicle Operations:
All operations without S/C

Combined Operations [POC]:
S/C – Launch Vehicle Integration

Countdown Execution:
Up to Lift-Off

2. General Range Support [GRS]

The General range Support provides the CUSTOMER, on a lump sum basis, with a number of standard services and standard quantities of fluids (see list hereafter).
Request(s) for additional services and/or supply of additional fluids exceeding the scope of the GRS can be accommodated, subject to negotiation between ARIANESPACE and the CUSTOMER.

2.1. Transport Services

Customer Personnel & Luggage:
Transport from and to Rochambeau Airport and Kourou at arrival departure, as necessary.

Spacecraft & Equipment:
Subject to advanced notice and performed nominally within normal CSG working hours.

Transport (see ① & ②):
Availability outside normal working hours, Saturdays, Sundays and Public Holidays subject to advance notice and negotiations.

From Cayenne to CSG and return.

Various Freight Categories (standard, hazardous, fragile, oversized loads, low speed drive, etc…).

Limited to 24 10ft pallets (or equivalent) in 2 batches (plane or vessel).

Spacecraft Inter-Site Transport (see ②):
All CSG Inter-Site Transports of the Spacecraft either inside the S/C container, the Payload Container [CCU], or encapsulated inside the Launch Vehicle Composite.

Inter-Site Equipment Transport (see ②):
All CSG Inter-Site Transports of CUSTOMER Equipment.

Logistics Support:
Support for Shipment and Customs procedures for the Spacecraft and its associated equipment, and for personal luggage and equipment transported as accompanied luggage.

Nota ①: The following is included in the Transport Service:

- Coordination of Loading/Unloading activities.
- Transport from Rochambeau Airport and/or Degrad-des-Cannes harbour to CSG.
- Return to Airport/Harbour 3 working days after Launch.
- Depalletisation of Spacecraft Support Equipment on arrival to CSG, and dispatching to the various working areas.
- Palletisation of Spacecraft Support equipment prior to departure from CSG to Airport/Harbour.
- All work associated with the delivery of freight by the Carrier at Airport/Harbour.
- CSG Support for the installation and Removal of the Spacecraft Check-Out Equipment.

The following is NOT included in the Transport Service:

- The "octroi de mer" tax on equipment permanently imported to Guiana, if any.
- Insurance for Spacecraft and its associated Equipment.

Nota ②: Maximum Temperature
The maximum temperature to which containers and packing may be exposed during any transport is 35°C.

2.2. Payload Preparation Facilities

The Payload Preparation Complex, with its personnel for support, may be used simultaneously by several customers. Specific facilities are dedicated to the CUSTOMER on the following basis:

EPCU Facilities

Standard conditions for temp. and relative humidity do not exceed 24°C and 55 %, respectively:

Spacecraft Preparation (clean Room)	400 m^2
Lab for Check-Out Stations (LBC)	120 m^2
Offices and Meeting Rooms	220 m^2

Access to the EPCU:
- Restricted to authorised personnel only, permanently controlled by Range Security.
- Access to offices, check-out stations and cleanrooms, is controlled through a dedicated electronic card system.
- Cleanrooms are permanently monitored by a CCTV camera/tape system.

Access outside normal working hours:
Access to the SC Preparation facilities beyond normal working hours, is authorised, subject to the following restrictions:
- No Range Support Provided.
- No hazardous Operations
- Crane utilisation only by certified personnel
- No changes to the Facilities Configurations

Schedule Restrictions:
Launch Campaign duration is limited to 49 calendar days, from S/C arrival in French Guiana, to actual departure of associated equipment.

Extension is possible, but is subject to negotiations.

Spacecraft Ground Support Equipment must be ready to leave the range within 3 working days after the Launch.

Transfer of S/C and its associated equipment to the SC Filling facilities no earlier than 21 working days before Launch.

After S/C transfer to Filling building, and upon request by ARIANESPACE, the Preparation clean room may be used by another S/C.

Range Operations:
Based on 2 Shifts of 8 hours per working day. 3 Shifts per day, and/or Saturday, Sunday or public holiday work is possible, but subject to negotiations.

Standard MGSE:
As per EPCU Manual.

No-break Power Supply:

Preparation Building	20 kVA
Filling Building	10 kVA
Launch Pad	10 kVA

Calibration Equipment:
As per EPCU Manual

Storage:
Any storage of equipment during the campaign
2 additional months for propellant storage

2.3. Communication Links

The following communication services between the different Spacecraft preparation facilities will be provided for the duration of a standard campaign (including technical assistance for connection, validation and permanent monitoring):

Service	Type	Number
RF-Link	Ku-Band (optical fiber)	1 TM / 1TC
Baseband Link	Optical fiber	2 TM / 2TC
Data Link	Romulus Network	4, for monitoring & remote control
Umbilical Link	Copperlines / COAX	2x37 pins for S/C umbilical & 2x37 pins for auxiliary equipment
Closed Circuit TV		As necessary
Intercom System		As necessary
Paging System		TBD
CSG telephone		As necessary
Int. Telephone Link (see ①)	With Access Code	< 10
Facsimile in Preparation building (see ①)		2
Video Conference (see ①)	Shared with other users	hours daily sessions

Note ① **:** Traffic to be paid, at cost, on CSG invoice after the campaign.

2.4. Analyses and Operations

Service	Type	Remarks
Chemical Analyses	Propellants	4 complete 10 partial, equiv. to 8 complete
	Gas & fluids particles	40 analyses
	Clean room organic deposit	1 weekly
Particle Count	Clean room monitoring	1 per day, one report weekly
S/C Weighing		In EPCU buildings
Adaptor Fit-Check	Mechanical / electrical TBD	At S/C arrival

2.5. Fluid Deliveries

Fluid	Type	Quantity
GN2	N48 at 190 bar	24 B50 bottles
GN2	Ground Supply in EPCU	As necessary
GHe	N55 at 350 bar	24 B50 bottles
IPA	MOS-SELECTIPUR	400 liters
Water	Deionised	As necessary

2.6. Miscellaneous

No-break power:
1.4 kVA in S1 offices for Customer PCs.

Copy machines:
2 in S1 area (1 for secretarial duties, 1 for extensive reproduction); paper provided.

Photo & Film processing:
~500 prints (13 x 18 cm) and one broadcast quality video tape (or 16 mm movie) of 15 min duration, to document S/C operations in French Guiana.

Video Transmission:
Coverage of the Launch, signal available at Bercenay (France) and ETAM (USA East Coast).

Video tape:
Launch Coverage (NTSC, PAL or SECAM).

2.7. Additional Services

Bilingual Secretary:
(French/English) during normal working hours.

Photographic Support:
For technical still pictures.

Room Reservation:
In the ARIATEL Hotel resort at Customer's request (cancellation charges, if any, under Customers's responsibility).

Customer Assistance - (Customer & Spacecraft Contractor):
For housing, rental cars, flight reservations, banking, off-duty & leisure activities.
The following list is an abstract of the "Tailored and Optional Services List" available for the customer and which is updated on a yearly basis.

3. Optional items and services

	N°	Latest date for option request (in months)
3.1. Launch vehicle hardware Pyrotechnic command Electrical command Dry loop command S/C Data via L/V T.M. Radio transparent window Additional access doors	**A xxx**	Refer to the applicable Tailored and Optional Services List for the year of the launch
3.2. Mission analysis Any additional Mission Analysis, dynamic analysis or flight program work due to changes made by the Customer.	**B xxx**	
3.3. Interface tests Any loan or purchase of equipment (adaptor, clampband, bolts, separation pyro set) can be envisaged and is subject to previous test plan acceptance by ARIANESPACE. <u>Mechanical compatibility test with ground test hardware.</u> **Not**e: Fit-check with flight hardware is performed on the range. <u>Mechanical compatibilty test – shock test</u> Additional – Shock test performed during same period. <u>Electrical or Radio Electrical Check</u>	**C xxx**	
3.4. Range operation Additional Shipment of spacecraft support equipment from Cayenne to CSG and return. Extra working shift. Transmission of TV Launch coverage to the point of reception requested by Customer. Additional spacecraft mass (propellant loading) over the contractual mass depending of the actual vehicle performance.	**D xxx**	

VEGA

Annex 3
Format for application to use VEGA

Format for Application to use VEGA Annex 3

1. Introduction

SPACECRAFT description and mission summary: Include a 3D view drawing of spacecraft in orbit, an exploded view and the coverage zones (if applicable).

<table>
<tr><td>Manufactured by</td><td colspan="2">Model</td></tr>
<tr><td>MASS
• Total mass at launch TBD kg
• Mass of satellite in TBD orbit TBD kg</td><td colspan="2">DIMENSIONS
• Dimensions TBD m
• Dimensions stowed for launch TBD m
• Dimensions deployed on orbit TBD m</td></tr>
<tr><td>STABILIZATION
• Spin*
• 3 axis*</td><td colspan="2">LIFETIME
TBD years</td></tr>
<tr><td>MISSION SUMMARY
• TBD operational channels of TBD bandwith
• Travelling wave tube amplifiers: TBD (if used)
• Transmit Frequency range: TBD W
• Receive Frequency range. TBD W
• EIRP: TBD</td><td>Telecommunication *
Direct broadcasting*
Meteorological*
Remote sensing*</td><td>Scientific*
Radiolocalisation*
Others*</td></tr>
<tr><td colspan="3">ANTENNAS (TM/TC)
Omniantenna direction and location</td></tr>
<tr><td colspan="3">PROPULSION SUB-SYSTEM
Brief description: TBD (liquid/solid, number of thrusters..)</td></tr>
<tr><td colspan="3">ELECTRICAL POWER
Solar array description (L x W)
Beginning of life power TBD W
End of life power TBD W
Batteries description TBD (type, capacity)</td></tr>
<tr><td colspan="3">ATTITUDE CONTROL
Type: TBD</td></tr>
<tr><td colspan="3">COVERAGE ZONES OF THE SATELLITE TBD (figure)</td></tr>
</table>

(*) To be selected.

2. Mission characteristics

2.1. Orbit description (if not standard GTO)

Specify elements:

- semi major axis,
- eccentricity,
- inclination,
- argument of perigee,
- any other elements constrained by the spacecraft,
- performance required.

2.2. Launch window(s) definitions

2.2.1. Constraints and relevant margins

Solar aspect angle, eclipse, ascending node, inclination, right ascension...

2.2.2. Preferred window

Computed using the reference time and reference orbit described in the AR4 User's Manual, the resulting launch window must include at least the
VEGA dual launch window as specified in the User's Manual for any launch period, and is preferably supplied as an electronic file (MS Excel). Constraints on opening and closing shall be identified and justified.

2.3. Separation conditions

2.3.1. Fixed orientation

The desired orientation at separation should be specified by the User with respect to the inertial perifocal reference frame [U, V, W] related to the orbit at injection time, as defined below:

U = radius vector with its origin at the center of the Earth, and passing through the intended orbit perigee.

V = vector perpendicular to U in the intended orbit plane, having the same direction as the perigee velocity.

W = vector perpendicular to U and V to form a direct trihedron (right-handed system [U, V, W]).

For circular orbits, the [U, V, W] frame is related to the orbit at a reference time (specified by Arianespace in relation with the mission characteristics) with U defined as radius vector with origin at the Earth and passing through the launcher CoG (and V, W as defined above).

In case of 3-axis stabilized mode, 2 of the 3 S/C axes [U, V, W] coordinates should be specified.
In case of spin stabilized mode, the S/C pin axes [U, V, W] coordinates should be specified.

2.3.2. Sun position dependant orientation

VEGA on-board flight program is able to perform any orientation in relation with the sun position at real separation time by assigning the launcher attitude to the actual lift-off time.
In case of 3-axis stabilized mode, the S/C axis to be related to the sun position should be specified.
If desired, a second S/C axis can also be constrained to a specific position.
In case of spin stabilized mode, the S/C spin axis orientation with regards to sun position should be specified.
For other reference position than sun position, the
Users should contact Arianespace.

2.3.3. Adjustment

For specific multiple launch, Mission Analysis may lead Arianespace to request a slight adjustment of
the desired orientation.

2.4. Roll and Attitude Control System (SCAR/SCA) sequence

Any particular constraints on SCAR/SCA sequence, launcher commands required.

2.5. Sequence of events after separation until final orbit (for information only)

Describe main maneuvers from separation until final orbit including apogee firing schedule.

3. Spacecraft description

3.1. Spacecraft Systems of Axes

Include a sketch showing the spacecraft system of axes, the axes are noted Xs, Ys, Zs and form a right handed set (s for spacecraft).

3.2. Spacecraft geometry in the flight configuration

A drawing and a reproducible copy of the overall spacecraft geometry in flight configuration is required.

It should indicate the exact locations of any equipment requiring access through shroud, lifting points locations and define the lifting device.

Detailed dimensional data will be provided for the parts of the S/C closest to the "static envelope" under shroud (antenna reflectors, deployment mechanisms, solar array panels, thermal protections,...).

Preferably, a 3D model (IGES extension) shall be supplied with the DUA.

3.3. Mass alignment inertia's
(Nominal values and tolerances)

The data required is for the spacecraft after separation. If the adaptor is user supplied, also add spacecraft in launch configuration with adaptor and adaptor just after separation.

3.3.1. Range of major/ minor inertia axis ratio

3.3.2. Dynamic out of balance (if applicable)

Indicate the maximum dynamic out of balance in degrees.

3.3.3. Angular momentum of rotating components

3.3.4. Table

Element (i.e. s/c adaptor)	Mass (kg)	C of G coordinates (mm)			Coefficients of inertia Matrix (kg. m2)					
		XG	YG	ZG	Ixx	Iyy	Izz	Ixy*	Iyz*	Izx*
Tolerances	(kg)	(mm)	(mm)	(mm)	mini maxi	mini maxi	mini maxi	mini maxi	mini maxi	mini maxi

Notes:

- C of G coordinates are given in spacecraft axes with origin of the axes at the separation plane.

- Inertia matrix is calculated in spacecraft axes with origin of the axes at the Center of gravity.

- The coefficients of the Inertia matrix must be given under 1 g conditions.
  (*) The cross inertia terms must be intended as the opposite of the inertia products (Ixy = - Pxy).

3.3.5. Propellant / pressurant characteristics

TANKS			1	2	3	4
PROPELLANT			NTO	MMH	NTO	MMH
DENSITY		(kg/m^3)	1450	876	1450	876
TANK VOLUME		(l)				
FILL FACTOR		(%)				
LIQUID VOLUME		(l)				
LIQUID MASS		(kg)				
CENTER OF GRAVITY OF PROPELLANT LOADED TANK		Xs				
		Ys				
		Zs				
SLOSH MODEL Under TBD g	PENDULUM MASS	(kg)				
	PENDULUM LENGTH	(m)				
	PENDULUM ATTACHMENT POINT	Xs				
		Ys				
		Zs				
	FIXED MASS (if any)					
	FIXED MASS	Xs				
	ATTACHMENT	Ys				
	POINT (if any)	Zs				
	FUNDAMENTAL SLOSHING MODE NATURAL FREQUENCY	(Hz)				

		PRESSURANT HELIUM			
TANKS		1	2	3	4
VOLUME	(l)				
LOADED MASS	(kg)				
CENTER OF GRAVITY (mm)	Xs				
	Ys				
	Zs				

3.4. Mechanical Interfaces

3.4.1. Spacecraft using Ariane supplied adaptor

3.4.1.1. Interface geometry

Provide a drawing with detailed dimensions and nominal tolerances showing: Spacecraft interface ring and keyway, spring seats and supports, umbilical connectors location and supports, separation sensors (if any), equipment in close vicinity of separation clampband (super insulation, plume shields, thruster).

3.4.1.2. Interface material description

For each spacecraft mating surface in contact with ARIANE adaptor and clampband, give: material,roughness, flatness, surface coating, rigidity (frame only), inertia and sufface (frame only).

3.4.2. S/C providing its own adaptor

Define adaptor and its interface with the launch vehicle (see specifications).

Define the characteristics of the separation system including:

1) Separation spring locations, type, diameter, free length, compressed length, spring constraint, energy.

2) Tolerances on the above.

3) Dispersion on spring energy vectors.

4) Dispersion of separation system.

5) Clampband tension.

6) Dispersion on pyro device actuation times.

3.4.3. Spacecraft accessibility requirements through shroud (fairing)

Indicate items on the spacecraft to which access is required through shroud and give their exact locations in spacecraft coordinates.

3.5. Electrical interfaces

3.5.1. Umbilical connectors(s) definition

3.5.2. Umbilical cable link between the spacecraft on tower and launch center and the spacecraft blockhouse console or COTE located in the launch center, the payload room CMCU, or the launch table, respectively.

Indicate voltage and current during launch preparation and also at POE extraction in the following tables.

Launch preparation

S/C connector pin allocation number	Function	Max voltage (V)	Max current (mA)	Max voltage drop (ΔV)	OR	Expected one way resistance (Ω)

POE extraction (Lift-Off)

Function	Max voltage (V)	Max current (mA)

3.5.3. Description of components, inserted mast junction box (if used)

Mechanical interface: max dimensions TBD.
Electrical interface: power: 1 kVA, 50 or 60 Hz.

3.5.4. Block diagram showing lines functions on spacecraft side and blockhouse side

3.5.5. Data links requirements (baseband and data network) between spacecraft and check-out system

3.5.6. Description of additional links, used after spacecraft erection on launch vehicle, for test or ground operations

3.5.7. Spacecraft earth potential reference point location on spacecraft interface frame

3.6. Radioelectrical interfaces

3.6.1. Radio link requirements and disruption between spacecraft, launch center, spacecraft check-out system and EPCU preparation buildings

3.6.2. Antenna(e) diagrams and directivity

Include transmit and receive points location of antenna(e) to be considered for radio links during launch preparation.

3.6.3. Spacecraft transmit and receive systems

3.6.3.1. Description of spacecraft telemetry and telecommand systems

3.6.3.2. Description of payload telecommunications system
(for information only)

3.6.3.3. System characteristics

3.6.3.3.1 On board system

For each TM and TC and system used on the ground and during launch, give the following:

SOURCE UNIT DESIGNATION		**S1**	**S2**	**S…**
Function				
Band				
Carrier Frequency, F_0 (MHz)				
Bandwidth centered Around F0	- 3 dB			
	-60 dB			
Carrier Modulation	Type			
	Index			
Carrier Polarization				
Local Oscillator Frequencies				
1st intermediate Frequency				
2nd intermediate Frequency				
EIRP, transmit (dbm)	Max			
	Nom			
	Min			
Field strength at antenna, receive (db V/M)	Max			
	Nom			
	Min			
Antenna	Designation			
	Location			
	Gain			
	Pattern			

3.6.3.3.2. Satellite ground station network

For each group station to be used for acquisition and GTO operations (nominal and back-up stations) please indicate the geographical location (latitude and longitude) and the radio-electrical horizon.

3.6.3.4. Spacecraft transmission plan

Source	Function	During preparation on launch pad	After H0-1h30 until 20s after separation	In transfer orbit	On station
S1					
S2					
S…					

3.7 Environmental characteristics

3.7.1 Fundamental modes (lateral, longitudinal) of spacecraft hardmounted at interface

3.7.2 Thermal characteristics during launch preparation and boost phase including thermal limits

3.7.3 Dissipated power during countdown and boost phase

3.7.4. Contamination characteristics and constraints

4. Operational requirements

4.1. Provisional range operations schedule

Include the definition of CCU interface and of the spacecraft lifting device

4.2 Spacecraft Preparation in EPCU building (if applicable)

4.2.1 Main operations list and description

4.2.2 Power requirements

Indicate Voltage, Amps, # phases, frequency category (standard or no break).

4.2.3 Facility equipment requirements

4.2.4 RF and hardline links requirements

4.2.5 Telecommunications requirements

Telephone, Facsimile, Data lines, Time code.

4.2.6 Miscellaneous

4.3 Solid Motor and pyro equipment preparation in building S2 (if applicable)

4.3.1 Main operations list and description

4.3.2 Power requirements

Indicate Voltage, Amps, # phases, frequency, category (standard or no break).

4.3.3 Facility equipment requirements

4.3.4 Miscellaneous

4.4 SPM X-Ray in building S4 (if applicable)

4.4.1 SPM description

4.4.2 GSE description

4.4.3 Facility equipment requirements (cold soak, films…)

4.5 Spacecraft fillinq and assembly in EPCU building

4.5.1 Main operations list and description

4.5.2 Power requirements

Indicate Voltage, Amps, # phases, frequency, category (standard or no break).

4.5.3 Facility equipment requirements

4.5.4 RF and hardline link requirements

4.5.5 Miscellaneous

4.6 Spacecraft preparation at servicing tower

4.6.1 Main operation list and description

4.6.2 Power requirements

Indicate Voltage, Amps, Frequency.

4.6.3 Facility equipment requirements

4.6.4 Miscellaneous

4.7. Transportation requirements

Give also dimensions and weights of any non standard container.

4.8 Hazardous items storage requirements

4.8.1 Propellants

4.8.2 Pyrotechnic devices

4.9 Fluids and propellants requirements

4.9.1 List of fluids

Indicate type, quality, quantity and location for use of fluids to be supplied by AE.

4.9.2 Chemical and physical analysis to be performed at the range

Indicate for each analysis: type and specification.

4.9.3 Safety garments needed for propellants loading

Indicate number and type.

5. General

5.1. Estimated packing list (including heavy and large container characteristics)

Indicate designation, number, size (L x W x H in m) and mass (kg).

5.2. Technical support requirements

Workshop, instrument calibration.

5.3 Hotel and cars reservations

Estimate number of hotel rooms and rental cars required for the campaign.

5.4. Miscellaneous services

6. Spacecraft development plan

7. Tests

7.1. Spacecraft test plan (vibration, acoustic, shocks...)

Define the qualifcation policy, qualification (protoflight or qualification model).

7.2. Requirements for test equipment (ACU's, clampband volume simulator...)

7.3. Tests on the user's premises

7.4. Tests at the range

8. Definitions, acronyms, symbols

ANNEX : Safety Submission Phase 1

The User prepares a file containing all the documents necessary to inform CSG of its plans with respect to hazardous systems. This file contains a description of the hazardous systems. It responds to all questions on the hazardous items check list given in the document CSG Safety Regulations V2 F3, and summarized here below.

1. Electro-pyrotechnic devices

1.1. Category-A initiators (for operations which could be hazardous for personnel and/or equipment)

1.2. Category-B igniters(for operations which are not hazardous)

1.3. Location

1.4. Function

1.5. Type and manufacturer

1.6. Production serial number

1.7. Bridge resistance

1.8 No-fire current

1.9 All fire current

1.10. Firing current

1.11. Selected firing current

1.12. Checkout current

1.13. Probabilities associated to those currents and confidence level

1.14. Time required for installation on spacecraft

1.15. Location in spacecraft

1.16. Radio-sensitivity characteristics

1.17. Electrostatic sensitivity characteristics

1.8. Electrical initiation and control circuits

2. Solid propellant motors

2.1. International classification

2.2. Manufacturer and references

2.3. Previous use

2.4. Description (structure, weight, nature of propellant)

2.5. Ignition system

2.6. Firing and monitoring circuit

2.7. Storage and transfer containers

2.8. Associated ground support equipment

3. Liquid Propellants

**3.1. Does the payload and/or associated ground equipment contain hazardous fluids.
If so, indicate quantities and specifications**

3.2. Description of the propulsion system

3.3. Location and operation procedures

4. Pressure vessels

4.2. Nature of fluids - Pressure

4.3. Tanks: type and manufacturer, structure, safety factor, qualification and acceptance tests

4.4. Associated ground support equipment

5. Batteries

5.1. Type of batteries – Description

5.2. Do they contain hazardous fluids ?

5.3. Charge

6. Radiation

6.1. Non-ionising radiations

- Antennas: locations, direction and characteristics.
- Radiation power, spectrum of frequencies, schedules and places of emission.
- Safety devices.
  venting (radioactive gas).
- Operations and safety regulations

6.2 Ionising radiations

- Do the spacecraft or associated ground equipment transmit ionising radiations?
- Kind of radiation, activity, forseeable
- exposition,

7. Interface (if not provided by the launcher authority)

7.1 Mechanical interfaces:

- Detailed description of the mechanical interface between the launcher and the payload (separation system).
- Detailed description of the mechanical and/or pneumatic between the launch tower and the payload.

7.2 Electrical interfaces

- Detailed description of the electrical Interface between the launcher (adaptor) and the payload; separation devices, monitoring means, safety devices (separation switches).
- Detailed description of the electrical Interface between the launch tower and the payload:
    - Preparation and test equipment
    - Operations (arming, battery charge,)
    - List of voltages and currents on the umbilical cable conductors at the moment of plug release

7.3 Umbilicals

- Type and number
- Fixation and extraction methods

8. Miscellaneous

8.1 Are the CSG Safety Regulations complied with?

8.2 Is any waiver requested?

8.3 Other safety problems not so far dealt with

VEGA

Annex 4
Spacecraft Accessibility

Spacecraft accessibility Annex 4

The following Figures show a projection of the interior of the fairing.
They show which areas are authorized, subject to negotiation, or prohibited for the location of access doors.

The standard version includes two access doors per spacecraft with an effective aperture 420 mm wide.

The distance between the centres of the circumscribed circles of two adjacent apertures must be greater than the sum of the diameters of these circles.

Any request for apertures outside the above limits will be subject to a special feasibility study.

TBD

Fig. A4-1 – Fairing access doors and R/F windows locations and dimensions

Annex 5
Usable volume under fairing

Usable volume under fairing Annex 5

The free volume available to the payload, known as the "static volume", is shown in the figure A5-1.

This volume constitutes the limits that the static dimensions of the spacecraft, including manufacturing tolerance, thermal protection, installation, appendices…, may not exceed.

Allowance has been made for the flexibility of the fairing and of the spacecraft.

The compatibility of the critical dimensions with the usable volume will be studied in greater depth by coupled load analysis, based on detailed informations provided by the User.

TBD

Fig. A5-1 – Usable volume beneath payload fairing

VEGA

Annex 6
Adaptors

Adaptor 937 Annex 6

This 937 adaptor is a carbon fibre structure in the form of a truncated cone, with a diameter of 937 mm at the level of the spacecraft separation plane.
It is attached to the reference plane (.... 2624) by a bolted connector frame, and also provides for spacecraft separation.

This 937 adaptor has a mass of TBD kg.

The actual spacecraft pair of values (Mcu, XG) must remain within admissible limits as defined in figure A6-1 using quasi-static load values indicated in paragraph 3.2.

The spacecraft is secured to the adaptor interface frame by a clampband. This comprises a metal strip applying a series of clamps to the payload and adaptor frames.
The clampband assembly comprises two half clampbands, connected by bolts which are cut pyrotechnically to release the clampband, which is then held captive by the adaptor assembly.

The clampband tension does not exceed 22 000 N at any time, it is defined to ensure no gapping between the spacecraft and adaptor interface frames in ground and flight environment.

The spacecraft is forced away from the launch vehicle by 4 springs integral with the adaptor and bearing on supports fixed to the spacecraft rear frame. The relative velocity between the adaptor and the spacecraft is about 0.5 m/s.

The force exerted on the spacecraft by each spring does not exceed: 900 N.

Adaptors are equipped either with external or internal springs on user request.

Two microswitches used to detect separation are located inside spring guides (see figure A6-6).

The adaptor assembly can provide bearing faces for the S/C microswitches aligned on the spring centre lines.

Umbilical connectors brackets: on the spacecraft side, the connectors brackets must be stiff enough to prevent any deformation greater than 0.5 mm under the maximum force of the connector spring.

Note: The adaptor cone is made of two parts:t The cone itself and the upper frame. In order to ease the clampband installation, the upper frame can be dismantled from the cone. Mating of the spacecraft is, in that case, performed in two steps: clampband installation, and then bolting of the spacecraft and adaptor upper frame to the cone. To perform this operation, a stiffening tool is used which reduced the diameter of the inner usable volume to 370 mm (see Figure A6-8).

TBD

Fig.A6-1- Limit loads of adaptor 937 at separation plane

TBD

Fig. A6-2- Adaptor 937
General view and main characteristics

TBD

Fig. A6-3- Adaptor 937
Spacecraft configuration view and main characteristics

TBD

Fig. A6-4- Adaptor 937
Forward frame

TBD

Fig. A6-5- Adaptor 937
Spacecraft Interface frame

TBD

Fig. A6-6- Adaptor 937
Adaptor mechanical interfaces (details)

TBD

Fig. A6-7- Adaptor 937
Spacecraft mechanical interface (details)

TBD

Fig. A6-8- Adaptor 937
Usable volume

VEGA

Annex 7
Dispensers

Dispensers Annex 7

1./ Introduction

Multiple launch configurations, in particular for constellations deployment may imply the use of a multiple payload carrying structure.

Arianespace has acquired the expertise of multiple payload launch and separations through the auxiliary payload launch service, well adapted to scientific, industrial research and university programs (up to seven satellite injected at a time during an ARIANE 4 mission).

Based on its experience and on the expertise of the European industry developing already such devices, ARIANESPACE proposes as part of its launch service the use of its dispensers.
The VEGA dispenser carries the satellites and provides the separation system.
It remains, or not, mated to the launcher after the payload separations, depending of the launch misssion.

Two conceptual design are proposed :

• Dispenser with central tube (boom dispenser), see figure 1 : this equipment can be used on the single launch configuration or on the dual launch configuration.
The tube diameter is optimized in order to maximize the volume offered to the payload and the number of satellites. The spacecraft is attached along one of its longitudinal faces on this structure.

• Dispenser with structural plate (platform dispenser), see figure 2 : this structure receives one adapter or adaptation per spacecraft . The spacecraft is mated through its base. Definition of the separation system and interfaces are coordinated with the user.
Such device being mission dependant, customers wishing to perform such a launch are requested to contact ARIANESPACE to optimize a pre-design of the satellite, based on ARIANESPACE experience and VEGA constraints.

2./ Environment specificities

Not Applicable

3./ Design and dimensioning requirement specificities

Not Applicable

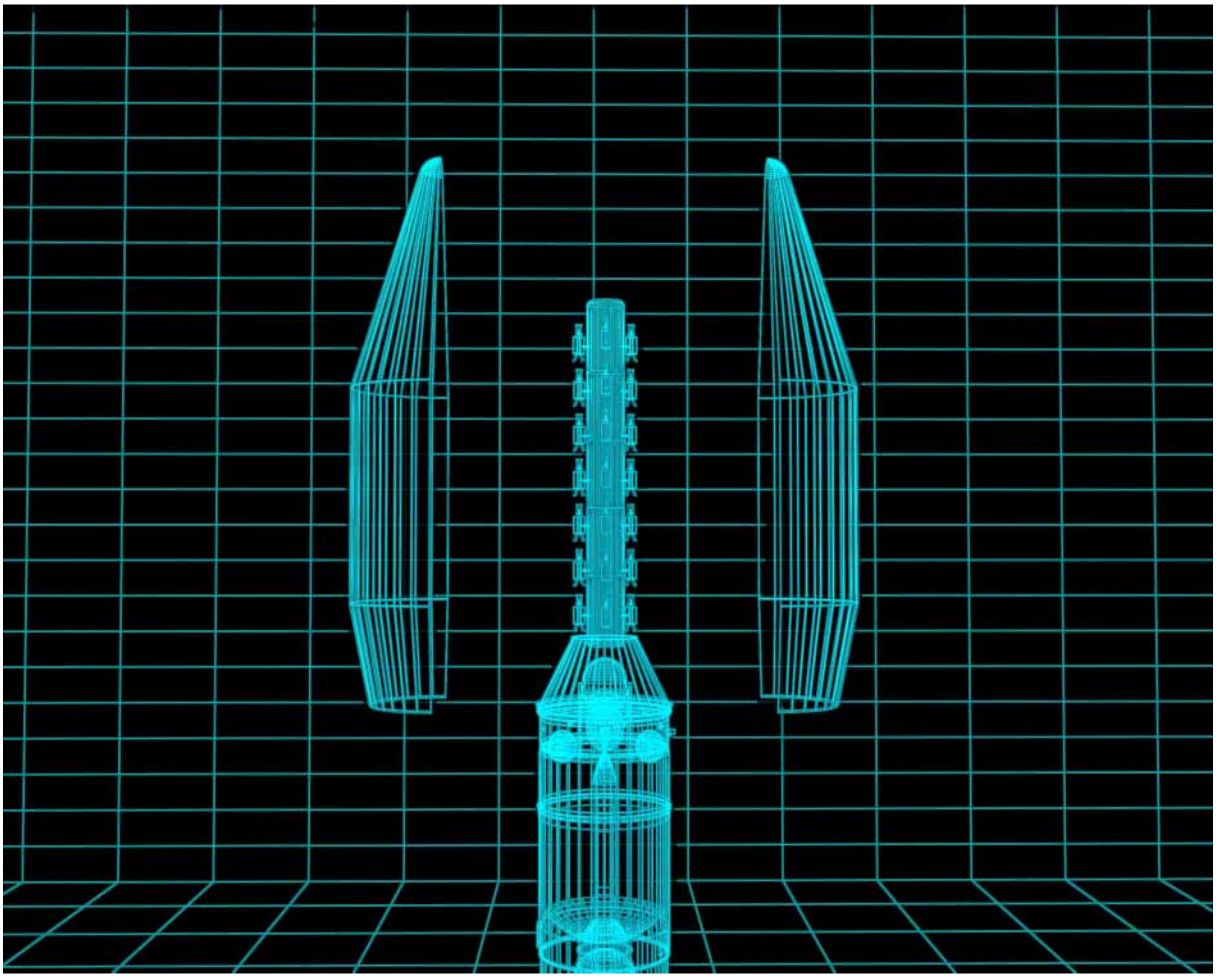


Fig .1 : VEGA multipurpose boom dispenser

TBD

Fig. 2 : Multipurpose platform dispenser